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SUPREME COURT, U.S.

TRANSCRIPT OF RECORD

Supreme Court of the United States

455

OCTOBER TERM, 1949

No. 455

AUTOMATIC RADIO MANUFACTURING COMPANY, INC., PETITIONER,

vs.

HAZELTINE RESEARCH, INC.

ON WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FIRST CIRCUIT

PETITION FOR CERTIORARI FILED NOVEMBER 14, 1949.

CERTIORARI GRANTED JANUARY 16, 1950.

No.

UNITED STATES CIRCUIT COURT OF APPEALS FOR THE FIRST CIRCUIT.

OCTOBER TERM, 1947.

AUTOMATIC RADIO MANUFACTURING COMPANY, INC.,

DEFENDANT, APPELLANT,

v.

HAZELTINE RESEARCH, INC.,

PLAINTIFF, APPELLEE.

APPEAL FROM THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF MASSACHUSETTS, FROM INTERLOCUTORY JUDGMENT (FORD, J.), JUNE 21, 1948.

TRANSCRIPT OF RECORD.

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UNITED STATES CIRCUIT COURT OF APPEALS FOR THE FIRST CIRCUIT.

OCTOBER TERM, 1947.

No.

AUTOMATIC RADIO MANUFACTURING COMPANY, INC.,
DEFENDANT, APPELLANT,

v.

HAZELTINE RESEARCH, INC.,
PLAINTIFF, APPELLEE.

TRANSCRIPT OF RECORD OF THE DISTRICT COURT.

No. 6677, CIVIL ACTION,

HAZELTINE RESEARCH, INC., Plaintiff,

v.

AUTOMATIC RADIO MANUFACTURING COMPANY, INC.,
Defendant.

APPEAL OF AUTOMATIC RADIO MANUFACTURING COMPANY, INC., DEFENDANT, FROM INTERLOCUTORY JUDGMENT ENTERED ON JUNE 21, 1948.

The complaint in this cause was filed in the Clerk's office on April 9, 1947, and was duly entered at the March Term of this Court, 1947, and is as follows:

COMPLAINT.

[Filed April 9, 1947.]

JURISDICTION.

1. Plaintiff is a corporation incorporated under the laws of the State of Illinois and brings this action as assignee of Hazeltine Corporation, a corporation incorporated under the laws of the State of Delaware.

2. Defendant is a corporation incorporated under the laws of the Commonwealth of Massachusetts, with its principal place of business at 122 Brookline Avenue in Boston, in the Commonwealth and District of Massachusetts.

3. The matter in controversy exceeds, exclusive of interest and costs, the sum of Three Thousand Dollars.

STATEMENT OF CLAIM.

4. On or about September 18, 1942 defendant and said Hazeltine Corporation for valuable consideration entered into an agreement in writing effective September 1, 1942, a copy of which agreement is filed herewith and identified as Exhibit A.

5. By said agreement, defendant agreed to make payments of moneys unto said Hazeltine Corporation and its assigns based upon defendant's sales of certain apparatus identified in Section 2 of Article III thereof, which payments of moneys were in any event to amount to a minimum of Ten Thousand Dollars ($10,000) for each year ending August 31; except that said minimum payment obligation was temporarily suspended during the continuance in force of Order No. L-265 of the War Production Board prohibiting the manufacture and sale for civilian use of certain apparatus covered by said agreement. By said agreement defendant also agreed to render monthly to said Hazeltine Corporation and its assigns written statements of the defendant's said sales.

6. On or about August 30, 1945 said Order No. L-265 was revoked, and on or about March 28, 1946 said Hazeltine Corporation, for valuable consideration, assigned to plaintiff the said agreement, together with all claims for unpaid royalties and

otherwise, and all other rights and obligations theretofore accrued or thereafter accruing thereunder, wherefore said agreement since August 30, 1945 has been in full force and effect and plaintiff is the sole owner of all the rights of said Hazeltine Corporation thereunder.

7. Since August 30, 1945, defendant has been extensively engaged in manufacture and sale of apparatus upon the sale of which money payments are due under said agreement, and defendant has failed and refused to pay the same either to said Hazeltine Corporation or to the plaintiff, has failed and refused to pay either to said Hazeltine Corporation or to the plaintiff the minimum sum due for the year ending August 31, 1946 under said agreement, and has failed and refused to render either to said Hazeltine Corporation or to the plaintiff the statements of defendant's sales as required by said agreement.

8. Plaintiff and its assignor, said Hazeltine Corporation, have each duly performed all of the obligations and conditions of said agreement on their part.

DEMAND FOR JUDGMENT.

Wherefore, the plaintiff prays for a judgment: That the defendant pay to the plaintiff the minimum sum due to the plaintiff for the year ending August 31, 1946 with interest at six per cent thereon; that an accounting be had and that the further sums due to the plaintiff from the defendant be determined and the defendant pay the same to the plaintiff with interest at the rate of six per cent per annum thereon; that defendant render to the plaintiff the statements required by said agreement throughout the continuance in force of said agreement; that defendant pay plaintiff's costs herein; and that plaintiff have such other and further relief as may be just.

ROBERTS, CUSHMAN & GROVER,
Attorneys for Plaintiff,
31 Milk Street,
Boston 9, Massachusetts.

LAURENCE B. DODDS,
1775 Broadway, New York 19, N. Y.
RICHARD F. WALKER,
31 Milk Street, Boston 9, Mass.
CLARENCE H. PORTER,
31 Milk Street, Boston 9, Mass.
Of Counsel.

LICENSE AGREEMENT

THIS LICENSE AGREEMENT dated as of Sept. 1st, 1942, between HAZELTINE CORPORATION, of Jersey City, New Jersey, a corporation of Delaware (hereinafter called Licensor), and AUTOMATIC RADIO MANUFACTURING COMPANY, INC., of Boston, Massachusetts, a corporation of Massachusetts (hereinafter called Licensee):

WITNESSETH THAT:

WHEREAS, Licensor represents that it owns or has the right to grant licenses under the United States patents enumerated in Schedule A attached hereto and under the United States patents to issue on the patent applications enumerated in said Schedule A attached hereto, and maintains laboratories with a staff of engineers, research men and inventors, and expects to file further patent applications and to obtain further United States patents important in the field of this Agreement; and

WHEREAS, Licensees of Licensor are entitled to certain privileges under certain United States patents as set forth in Schedule B attached hereto, and

WHEREAS, Licensee desires a license under such patents issued and to be issued and under said applications,

NOW, THEREFORE, in view of the premises and in consideration of the licenses herein granted and agreed to be granted, the mutual covenants and agreements herein contained, any releases executed concurrently herewith, it is agreed as follows:

ARTICLE I

~~Settlement of Damages~~

~~Licensee agrees to pay and Licensor agrees to accept in full satisfaction of Licensor's claims for profits and damages arising out of Licensee's unlicensed manufacture, use or sale of apparatus of the type licensed hereunder prior to the date hereof the sum of _____ Dollars ($_____). It is further agreed that such sum is now due and payable to Licensor, of which _____ Dollars ($_____)~~

~~is herewith paid, receipt of which is acknowledged by Licensor. The balance of the first mentioned sum, Dollars ($) shall be liquidated by Licensee paying to Licensor on each "Royalty Day" a sum equal to per cent (%) of the amount of royalties due from Licensee on such Royalty Day, as determined hereinafter, until the balance of Dollars ($) has been paid.~~

ARTICLE II

Definitions

For the purposes of this license Agreement the following definitions shall apply:

Section 1. A "complete radio broadcast receiver" of sound or pictures means a complete apparatus fully equipped with tubes, in the condition in which it is to be sold to the ultimate purchaser for use and fully operative (except for any antenna not particularly designed and sold by Licensee to function with such receiver and except for a primary source of power, such as batteries or house wiring) for receiving radio broadcast signals and for converting them into audible or visual signals, one or both as the case may be.

Section 2. A "chassis of a radio broadcast receiver of sound" means a complete radio broadcast receiver of sound in accordance with Section 1, less the cabinet or housing and less the tubes or speaker or both.

Section 3. A "complete carrier current receiver" of sound or pictures means a complete apparatus fully equipped with tubes in the condition in which it is to be sold to the ultimate purchaser for use and fully operative (except for a primary source of power, such as batteries or house wiring) for receiving signals transmitted over wires (such, for example, as power lines) and for converting such signals into audible or visual signals, one or both, as the case may be.

Section 4. "Pictures" means light images, shadows, reflections, and other visible reproductions, of the aspect or shape of animate or inanimate objects, or of drawings, writing, forms, and other graphic, printed and written matter of all kinds.

SECTION 5. "Complete electric phonographs" and "complete apparatus for reproducing talking pictures" means respectively electric phonographs and apparatus for reproducing talking pictures which are complete, fully equipped with tubes, in the condition in which they are respectively to be sold to the ultimate purchaser for use and fully operative for accomplishing the purposes set forth respectively in the definitions of Section 6 of this Article.

SECTION 6. "Electrical phonograph" and "apparatus for reproducing talking pictures" mean respectively apparatus for the reproduction of sound from sound records and pictures from picture records used in or in connection with such apparatus, to be heard or seen in the immediate vicinity of the apparatus, in which such record gives rise to or controls an electric current or electromotive force in such a way that the variations of the electric current or electromotive force correspond in some way to the recorded sounds or pictures, and the electric current or electromotive force directly or indirectly brings about the production of sound or pictures from the apparatus, and also, when furnished as parts thereof, apparatus for making sound and picture records for use in or in connection with, such electrical phonographs and apparatus for reproducing in the home talking pictures for private entertainment or private education.

SECTION 7. "Tube" means an electron discharge device consisting of an envelope which contains two or more electrodes and which is to any extent evacuated or contains gas or vapor under any degree of pressure and is capable of changing the form of or controlling or modifying energy supplied thereto used for any purpose under this license.

ARTICLE III

LICENSES

SECTION 1. Licensor hereby grants and agrees to grant under all United States Letters Patents of Schedule A and under all the United States Letters Patents to issue on the applications of Schedule A and under all other United States Letters Patents and applications with respect to which during the term hereof it shall have the right to grant licenses (but, in the case of patents and applications under which Licensor has or shall subsequently acquire a limited right to grant

licenses for part or all of the field hereof, the licenses herein granted are subject to any limitations to which that right may be subject), and upon the terms and conditions hereinafter set forth and solely and only to the extent and for the uses hereinafter specified and defined, a personal, indivisible, non-transferable and non-exclusive license to Licensee to manufacture at its factory located at 122 Brookline Avenue, Boston in the State of Massachusetts, and not elsewhere without previous written permission obtained from Licensor, the apparatus specified in Section 2 hereinafter and to sell (but not to lease or otherwise dispose of) said apparatus manufactured by Licensee as a whole to others for the uses specified in Section 2 hereinafter and for resale for such uses. The license to manufacture includes the right to make all or any of the separate parts and the right to have all or any of the separate parts made by others, but no license is granted to sell parts separately except for bona fide repair of used apparatus or replacement of worn-out or defective parts of used apparatus.

SECTION 2. The apparatus for which the said license is granted is as follows; the use in each case is limited to use in homes, use for educational purposes and private non-commercial use:

(a) Complete radio broadcast receivers of sound;

(b) Complete radio broadcast receivers of pictures (including television):

(c) Chassis of radio broadcast receivers of sound;

(d) Complete carrier current receivers of sound;

(e) Complete carrier current receivers of pictures;

(f) Complete electrical phonographs;

(g) Complete apparatus for reproducing pictures and talking pictures, from films or other records used in such apparatus, to be seen or heard in the immediate vicinity of such apparatus; and

(h) Combination of the apparatus specified in (a), (b), (f) and (g) of this section or of any two or more of them.

SECTION 3. Nothing herein contained, and no act or acts hereunder, shall be construed as, or result in, conveying any license to Licensee, expressly or by implication, estoppel or otherwise:

(a) Under any Letters Patent which or rights under which are held by Licensor under an agreement such that Licensor can grant licenses only upon the payment of royalties or other consideration by Licensor to others. Provided, however, that Licensor will from time to time keep Licensee informed of all such agreements and that Licensee may at any time obtain rights under such agreements corresponding to the licenses herein granted, so far as such agreements permit, on engaging to pay to Licensor any amounts which Licensor has to pay under such agreements because of Licensee's exercise of such rights;

(b) Under any patents of countries foreign to the United States;

(c) To manufacture or sell apparatus otherwise than in accordance with the express provisions of this license Agreement.

ARTICLE IV

Royalties

Section 1. Licensee agrees to pay to Licensor upon each complete apparatus identified in Article III, Section 2, sold by Licensee during continuance of this license royalties as follows:

(a) Upon apparatus identified in sub-sections (a), (b), (d), (e), (f), (g) and (h), Licensee agrees to pay to Licensor a royalty of one and five-hundredths per cent. (1.05%) of Licensee's selling price of said complete apparatus.

(b) Upon apparatus identified in sub-section (c), Licensee agrees to pay to Licensor a royalty of two and one-tenth per cent. (2.1%) of Licensee's selling price of said apparatus less Licensee's actual cost of the tubes and speaker, or either of them, if sold therewith.

The selling price on which royalty is computed in any case is the selling price before any deduction for cash discounts, or for any freight, advertising or other allowances but after deductions of manufacturers' excise taxes actually paid by Licensee directly to the taxing authority.

SECTION 2. In order to insure to Licensor the full royalty payments contemplated under Section 1 of this Article, namely, royalty on selling prices to purchasers wholly independent of Licensee, it is agreed that, in the event that any apparatus is sold hereunder:

(1) To a corporation, firm or association which, or individual who, shall own or control directly or indirectly a controlling interest in Licensee by stock ownership or otherwise; or

(2) To a corporation, firm or association in which Licensee or stockholders of Licensee, or any subsidiary or parent or affiliated company of Licensee shall own or control directly or indirectly a controlling interest by stock ownership or otherwise; or

(3) To a corporation, firm, or association to which, or individual to whom Licensee sells exclusively or which or who purchases exclusively from Licensee apparatus of the type licensed, either as a matter of general practice or under the provisions of any sales agreement, arrangement, or understanding between the parties; or

(4) To a corporation, firm or association with which, or individual with whom, Licensee or its stockholders or subsidiary or parent or affiliated companies shall have any agreement, understanding or arrangement (such as, among other things, an option to purchase stock or involving a division of profits or special rebates or allowances) without which agreement, understanding or arrangement, prices paid by such corporation, firm or association or individual for the apparatus sold hereunder would be higher than the price actually paid, or if such agreement, understanding or arrangement results in extending to such corporation, firm, association or individual lower prices for the apparatus sold hereunder than those charged to outside concerns buying similar merchandise from Licensee in similar amounts and under similar conditions;

then, and in any of such events, the royalties to be paid hereunder in respect of such apparatus shall be upon the net selling price, before cash discount, freight or advertising allowance or other similar

deductions, at which such purchaser resells such apparatus to a purchaser wholly independent of itself and of Licensee, instead of upon the net selling price of Licensee, provided, however, that Licensee shall not be obligated under this section to pay royalty upon selling prices of apparatus in excess of the standard price at which Licensee sells such apparatus to any wholly independent jobber or distributor.

SECTION 3. For royalty purposes under this Agreement apparatus shall be considered to be sold when billed out, or if not billed out then when delivered, shipped or mailed, or when paid for if paid for before delivered, shipped or mailed; but royalties paid on articles which are not accepted by the customer shall be credited against further royalty payments to be made hereunder.

SECTION 4. In case the royalties accrued and paid by Licensee hereunder do not aggregate a minimum of Ten Thousand Dollars ($10,000) for the year ending Aug.31,1943 , and for each succeeding year during the life of this Agreement, Licensee agrees within thirty (30) days of the end of each such year to make up the deficiency of the actual royalties paid to such minimum sum.

SECTION 5. By giving notice to Licensor on or before July 1st of any year ~~(except that for the year beginning , 19 , said notice shall be given on or before , 19)~~ that it desires and agrees to pay a lump sum royalty for the year beginning said July 1st in accordance with and subject to the following terms and conditions instead of the royalties provided for by Section 1 of this Article, Licensee shall be released from the obligations of Section 1 of this Article for the period of one year beginning said July 1st.

(a) The lump sum payment shall be One Hundred and Five Thousand Dollars ($105,000), which sum Licensee agrees to pay as follows: one-quarter at the time of giving said notice; one-quarter on or before the following October 1st; one-quarter on or before the following January 2nd; one-quarter on or before the following April 1st.

(b) Except as provided in sub-section (d) hereinafter, the apparatus for which this sum shall be a royalty payment shall be all apparatus which is sold by Licensee hereunder

during the year July 1st to June 30th, inclusive, immediately following said notice and which is sold for resale under the trade mark or brand name specified under sub-section (c).

(c) Licensee shall at the time of giving said notice designate a brand name or trade mark identified with Licensee's radio business under which all apparatus included within this lump payment is to be marketed and agrees that all such apparatus will have said brand name or trade mark permanently and conspicuously affixed thereto.

If Licensee finds that in the normal conduct of its business it is desirable to sell apparatus under more than one brand name or trade mark, it may apply to Licensor for permission to use additional specified trade marks or brand names, but apparatus sold under such other trade marks or brand names shall not be included in this lump sum payment unless said permission is granted in writing by Licensor.

(d) Apparatus or parts thereof manufactured for or sold to other radio manufacturers or other licensees of Licensor (except apparatus designed and intended for installation in automobiles, aeroplanes and motor boats and manufactured for or sold to automobile manufacturers, aeroplane manufacturers and motor boat manufacturers which may be licensees of Licensor) or manufactured by or purchased from other licensees of Licensor is not included in the apparatus for which this lump sum is a royalty payment.

ARTICLE V

Reports and Payments

Section 1. Licensee agrees that it will keep records showing the production and the sales of all apparatus coming within the scope of this Agreement in sufficient detail to enable the royalties payable hereunder to Licensor to be determined, and generally to allow such investigation of all its operations hereunder and in connection herewith as may be necessary to determine Licensee's compliance with this Agreement and the accuracy of said records and the statements to be furnished here-

under. Licensee further agrees to permit Licensor's duly authorized representative, or at the option of Licensee a reputable certified public accountant designated by Licensor, to inspect such records at all reasonable times.

SECTION 2. Within fifteen (15) days after, and as of, the first day of each month (hereinafter referred to as "Royalty Day") Licensee agrees to furnish Licensor with written statements under oath of some officer of Licensee, specifying as to each model or type sold by Licensee (except apparatus included under the lump sum payment of Article IV, Section 5) (a) Licensee's model number or type designation; (b) the trade or brand name; (c) the total number produced during the preceding month; (d) the total number of apparatus sold under this Agreement by Licensee during the preceding month; (e) Licensee's selling price and, in the case of apparatus coming under Article IV, Section 1. (b), (1) Licensee's selling price before the deductions thereunder; (2) the nature of the apparatus for which such deductions are made; (3) the amount of such deductions; and (4) the amount upon which royalty is payable; and (f) the amounts of royalties payable thereon as provided in Article IV hereof. Said statement shall also include a statement under oath that all conditions of this license have been complied with.

The first of such statements shall be rendered not later than the fifteenth (15th) day after the Royalty Day next following the date of this license Agreement, as of such Royalty Day, and shall cover the period from the date of this license Agreement to said Royalty Day. The royalty prescribed herein shall be due and payable on the fifteenth (15th) day of each month upon all such apparatus sold by Licensee during the preceding month, or, in the case of the first statement, the period covered thereby.

If in any such period no apparatus has been sold on which royalty is payable under Article IV, Section 1, a statement under oath so stating shall be furnished to Licensor.

SECTION 3. Licensee agrees to pay interest to Licensor upon any and all amounts of royalties that are at any time overdue and payable to Licensor at the rate of six per cent. (6%) per annum from the date when such royalties are due and payable as provided herein.

SECTION 4. Licensor agrees not to disclose to a competitor of Licensee any confidential information relating to Licensee's business obtained by the Licensor under this Agreement, except when combined statistically with corresponding information of other licensees in such manner as to conceal said information, and except as it may be necessary to disclose the information in or in connection with any arbitration or litigation.

ARTICLE VI

TRADE MARK AND PATENT MARKINGS

SECTION 1. Licensee agrees to mark on all apparatus identified in Article III, Section 2, sold by it under this license the word " AUTOMATIC ", or such other trade mark, trade name or brand name as Licensee shall from time to time specify in writing to Licensor. Such trade mark or trade or braind name shall be etched, stamped, or in some other permanent form affixed on every such piece of apparatus and apparatus not bearing said word, name or trade mark is not licensed. Nothing in this section shall be construed to modify the restrictions of Article IV, Section 5.

Section 2. Licensee agrees to mark all licensed apparatus manufactured and sold by Licensee hereunder, in readily legible form, with the statement "Licensed by Hazeltine Corporation only for use in homes, for educational purposes, and for private, non-commercial use, under one or more of the following patents and under pending applications:" followed by the word "Patent" and the numbers of the patents which are, in the opinion of Licensor, involved in apparatus of the types licensed hereunder manufactured by one or more licensees of Licensor. The marking required by this section shall be affixed to said licensed apparatus by attaching plates bearing the required marking or by affixing said marking on said apparatus in some other form equally permanent and apparatus not bearing such marking is not licensed.

SECTION 3. Upon request of Licensor, Licensee agrees to submit to Licensor a sample or complete specifications with the necessary technical information on all new models of apparatus to be sold hereunder so as to enable Licensor to advise Licensee which patent numbers should

be included in the patent marking provided by Section 2 of this article. Licensee agrees that no such new model shall be released for sale until the requirements of this section have been complied with, except that if Licensor fails to provide Licensee with the patent marking information within ten (10) days after receipt by Licensor of sample or complete specifications and of request by Licensee for said information, Licensee may release such apparatus for sale marked with the patent marking supplied by Licensor for similar apparatus.

SECTION 4. Licensee further agrees to use its best efforts to include in any and all catalogues, circulars, or price lists, of Licensee with reference to apparatus to be sold hereunder the statement: "Licensed under Hazeltine Corporation Patents."

ARTICLE VII

WAIVER

No waiver by Licensor, express or implied, of any breach of any term, condition or obligation of this Agreement by Licensee shall be construed as a waiver of any subsequent breach of that term, condition or obligation, or any other term, condition or obligation of the Agreement of the same or different nature.

ARTICLE VIII

LITIGATION

SECTION 1. Licensor agrees that it will bring and diligently prosecute such suits for infringement of the various patents under which licenses are herein granted as may in its judgment be reasonably necessary and prudent for enforcing those patents and preventing unlicensed competition in patented apparatus in the field of this license.

SECTION 2. Licensee agrees that it will cooperate with Licensor in said enforcement of patents and prevention of unlicensed competition in patented apparatus, including the furnishing of statistical and technical information and other facts relating to such enforcement and prevention, provided that such cooperation shall be at the cost of Licensor and shall not unreasonably interfere with any of Licensee's operations.

ARTICLE IX

Notices

Any notice hereunder must be in writing and may be given by registered letter and shall be deemed to have been given when such registered letter, properly addressed, is mailed; if given otherwise than by registered letter, it shall be deemed to have been given when delivered. If such notice is to be given to Licensor it shall be addressed to Licensor at its office, 15 Exchange Place, Jersey City, New Jersey; if given to Licensee it shall be addressed to Licensee at 122 Brookline Avenue, Boston, Massachusetts. Either party hereto may at any time by thirty (30) days' notice to the other designate any other address in place of those above given.

ARTICLE X

Term and Termination

Section 1. Unless sooner terminated as herein provided, the license herein granted shall extend for a period of ten (10) years from the effective date hereof and, unless Licensee shall have fully and faithfully performed all its obligations hereunder and shall have given six (6) months' written notice to Licensor prior to the end of such ten (10) year period of its election to terminate such license, thereafter for an additional period of three (3) years.

Section 2. Licensor may, at its option, terminate this Agreement, (a) on the failure of Licensee to render statements, to pay royalties or to make any other payments due under this Agreement within ten (10) days after its attention has been called to its failure to do so; (b) on Licensee's failure to comply with any other provision of this Agreement; (c) at any time upon or during the bankruptcy, receivership or insolvency of Licensee or the appointment of a receiver or trustee for its property, or upon or after an assignment for the benefit of creditors, or upon the filing of a petition, either voluntary or involuntary, for financial reorganization of Licensee or other adjustment of its indebtedness. Any such termination by Licensor shall be by notice in writing to Licensee, stating the reason for the termination and shall take effect ten (10) days after such notice is given.

SECTION 3. In the event of any default of Licensee identified in Section 2, sub-section (a) of this Article, whether or not Licensor has terminated this Agreement in accordance with the provisions of said section, there shall thereupon become payable by Licensee the minimum royalty of Ten Thousand Dollars ($10,000) specified in Article IV, Section 4, for each calendar year during any portion of which Licensee shall be in default or for the prorated portion of any such calendar year including the date of commencement of this Agreement or the date of termination under the provisions of Section 1 of this Article, in case such date of commencement or termination shall be other than at the beginning or end, respectively, of a calendar year.

SECTION 4. All licenses shall cease on the date of termination. Apparatus manufactured during the life of the Agreement and on which royalty has been paid within thirty (30) days after the termination shall be licensed to be sold in accordance with the terms and conditions hereof. Within thirty (30) days after the termination Licensee shall report and pay royalties as above provided.

SECTION 5. No termination of this license Agreement for any cause shall release Licensee from any of the liabilities accruing to Licensor or rescind anything done or any payment or other consideration made or given to either party hereunder prior to the time such termination becomes effective. No failure on the part of Licensor to exercise any right of termination hereunder shall be construed to prejudice any subsequent right of termination.

ARTICLE XI

SUCCESSORS AND ASSIGNS

Neither this Agreement nor any of its benefits, nor the licenses, rights or privileges herein granted shall be directly or indirectly, by operation of law or otherwise, assigned, transferred, divided or shared by Licensee with any person, firm or corporation whatsoever, without the written consent of Licensor. This Agreement shall inure to the benefit of the successors or assigns of Licensor, but neither the Agreement nor the licenses, rights or privileges herein granted shall inure to the benefit of the successors, assigns or any legal representatives of Licensee without the written consent of Licensor having first been obtained.

ARTICLE XII

New York Laws

This Agreement is to be governed by and interpreted in accordance with the laws of the State of New York.

IN WITNESS WHEREOF, the parties hereto have caused this instrument to be executed in duplicate by their proper officers thereunto duly authorized.

HAZELTINE CORPORATION,

By Jack Binns
President.

ATTEST:

Lawrence B Dodds
Assistant Secretary.

AUTOMATIC RADIO MANUFACTURING COMPANY, INC.

By Harold Lyman
President.

ATTEST:

John J. Grady
Secretary.

State of New York
County of New York } ss.:

On this 18th day of September, 1942, before me personally came Jack Dennis, to me known, and who being by me duly sworn, did depose and say: that he is the President of Hazeltine Corporation, one of the corporations described in and which executed the above instrument, and that he knows the seal of said corporation, and the seal affixed to said instrument is said corporate seal, and that it was so affixed by authority of the Board of Directors of the said corporation, and that he signed his name thereto by like authority.

Peggy Coyle
Notary Public.

PEGGY COYLE
NOTARY PUBLIC Kings County
Kigns Co. Clk's No. 61. Reg. No. 4080
N. Y. Co. Clks' No. 128. Reg. No. 4070
Commission expires March 30, 1944

State of Mass.
County of Suffolk } ss.:

On this 17th day of September, 1942, before me personally came David Houseman, to me known, and who being by me duly sworn, did depose and say: that he is the President of Automatic Radio Mfg Co., Inc. one of the corporations described in and which executed the above instrument, and that he knows the seal of said corporation, and the seal affixed to said instrument is said corporate seal, and that it was so affixed by authority of the Board of Directors of the said corporation, and that he signed his name thereto by like authority.

Hyman Bentzel
Notary Public.

My Commission Expires 9/1/47

Schedule A.

HAZELTINE CORPORATION

United States Letters Patent and Applications

Patent No.	*Issued*
1,524,580	Jan. 27, 1925
1,524,581	Jan. 27, 1925
1,533,858	April 14, 1925
1,535,189	April 28, 1925
1,562,952	Nov. 24, 1925
1,577,421	Mar. 16, 1926
1,582,460	April 27, 1926
1,605,411	Nov. 2, 1926
1,605,627	Nov. 2, 1926
1,625,776	April 19, 1927
1,639,698	Aug. 23, 1927
1,640,710	Aug. 30, 1927
1,648,808	Nov. 8, 1927
1,649,589	Nov. 15, 1927
1,658,638	Feb. 7, 1928
1,660,930	Feb. 28, 1928
1,672,641	June 5, 1928
1,677,355	July 17, 1928
1,680,424	Aug. 14, 1928
1,683,202	Sept. 4, 1928
1,692,257	Nov. 20, 1928
1,695,842	Dec. 18, 1928
1,698,364	Jan. 8, 1929
1,710,035	April 23, 1929
1,721,520	July 23, 1929
1,733,504	Oct. 29, 1929
Re. 17,530	Dec. 17, 1929
1,755,114	April 15, 1930
1,755,115	April 15, 1930
1,757,494	May 6, 1930
1,762,431	June 10, 1930
1,763,380	June 10, 1930
1,763,796	June 17, 1930
1,776,592	Sept. 23, 1930
1,781,759	Nov. 18, 1930
1,798,962	Mar. 31, 1931

Patent No.	*Issued*
1,823,327	Sept. 15, 1931
1,823,331	Sept. 15, 1931
1,829,058	Oct. 27, 1931
1,831,431	Nov. 10, 1931
1,844,374	Feb. 9, 1932
1,845,306	Feb. 16, 1932
1,846,701	Feb. 23, 1932
1,855,054	April 19, 1932
1,855,055	April 19, 1932
1,855,619	April 26, 1932
1,857,055	May 3, 1932
1,866,687	July 12, 1932
1,868,155	July 19, 1932
1,869,894	Aug. 2, 1932
1,873,236	Aug. 23, 1932
1,875,837	Sept. 6, 1932
1,878,614	Sept. 20, 1932
1,878,653	Sept. 20, 1932
1,878,740	Sept. 20, 1932
1,878,741	Sept. 20, 1932
1,878,742	Sept. 20, 1932
1,878,743	Sept. 20, 1932
1,879,861	Sept. 27, 1932
1,879,862	Sept. 27, 1932
1,881,235	Oct. 4, 1932
1,881,284	Oct. 4, 1932
1,883,794	Oct. 18, 1932
1,888,278	Nov. 22, 1932
1,892,354	Dec. 27, 1932
1,893,813	Jan. 10, 1933
1,894,503	Jan. 17, 1933
1,895,091	Jan. 24, 1933
1,896,500	Feb. 7, 1933
1,904,185	April 18, 1933
1,907,916	May 9, 1933
1,908,934	May 16, 1933
1,910,399	May 23, 1933
1,910,827	May 23, 1933
1,910,870	May 23, 1933
1,913,604	June 13, 1933
1,913,693	June 13, 1933

Patent No.	*Issued*
1,921,067	Aug. 8, 1933
1,921,068	Aug. 8, 1933
1,927,672	Sept. 19, 1933
1,930,784	Oct. 17, 1933
1,931,338	Oct. 17, 1933
1,931,596	Oct. 24, 1933
1,933,402	Oct. 31, 1933
1,934,722	Nov. 14, 1933
1,942,587	Jan. 9, 1934
1,942,786	Jan. 9, 1934
1,943,405	Jan. 16, 1934
1,951,685	Mar. 20, 1934
1,958,027	May 8, 1934
Re. 19,170	May 15, 1934
1,960,984	May 29, 1934
1,961,154	June 5, 1934
1,961,574	June 5, 1934
1,968,973	Aug. 7, 1934
1,977,745	Oct. 23, 1934
1,997,665	April 16, 1935
2,000,084	May 7, 1935
2,000,113	May 7, 1935
2,001,950	May 21, 1935
2,007,253	July 9, 1935
2,013,121	Sept. 3, 1935
2,014,086	Sept. 10, 1935
2,015,327	Sept. 24, 1935
2,016,760	Oct. 8, 1935
2,018,526	Oct. 22, 1935
2,018,540	Oct. 22, 1935
2,018,545	Oct. 22, 1935
Re. 19,744	Oct. 29, 1935
2,020,166	Nov. 5, 1935
2,021,692	Nov. 19, 1935
Re. 19,765	Nov. 26, 1935
2,022,067	Nov. 26, 1935
2,022,068	Nov. 26, 1935
2,022,085	Nov. 26, 1935
2,022,514	Nov. 26, 1935
2,024,002	Dec. 10, 1935
2,024,017	Dec. 10, 1935

Patent No.	*Issued*
2,026,075	Dec. 31, 1935
2,026,102	Dec. 31, 1935
Re. 19,823	Jan. 14, 1936
2,028,511	Jan. 21, 1936
2,034,013	Mar. 17, 1936
2,034,014	Mar. 17, 1936
2,036,319	April 7, 1936
2,036,343	April 7, 1936
2,038,253	April 21, 1936
2,038,294	April 21, 1936
2,038,338	April 21, 1936
2,038,359	April 21, 1936
2,039,136	April 28, 1936
2,041,273	May 19, 1936
2,041,291	May 19, 1936
2,042,571	June 2, 1936
2,045,569	June 30, 1936
2,045,910	June 30, 1936
2,048,527	July 21, 1936
2,048,528	July 21, 1936
2,049,147	July 28, 1936
2,050,679	Aug. 11, 1936
2,050,680	Aug. 11, 1936
2,052,183	Aug. 25, 1936
2,052,184	Aug. 25, 1936
2,054,412	Sept. 15, 1936
2,054,424	Sept. 15, 1936
2,056,390	Oct. 6, 1936
2,058,565	Oct. 27, 1936
2,061,991	Nov. 24, 1936
2,064,774	Dec. 15, 1936
2,064,775	Dec. 15, 1936
2,066,777	Jan. 5, 1937
2,072,679	Mar. 2, 1937
2,072,708	Mar. 2, 1937
2,073,038	Mar. 9, 1937
2,073,344	Mar. 9, 1937
2,073,345	Mar. 9, 1937
2,075,683	Mar. 30, 1937
2,077,045	April 13, 1937
2,077,049	April 13, 1937

Patent No.	*Issued*
2,080,115	May 11, 1937
2,080,560	May 18, 1937
2,080,646	May 18, 1937
2,081,861	May 25, 1937
Re. 20,400	June 8, 1937
2,084,647	June 22, 1937
2,092,709	Sept. 7, 1937
2,093,416	Sept. 21, 1937
2,099,156	Nov. 16, 1937
2,100,402	Nov. 30, 1937
2,100,733	Nov. 30, 1937
2,103,022	Dec. 21, 1937
2,103,079	Dec. 21, 1937
2,103,097	Dec. 21, 1937
2,105,902	Jan. 18, 1938
Re. 20,632	Jan. 18, 1938
2,110,664	Mar. 8, 1938
2,111,483	Mar. 15, 1938
2,115,463	April 26, 1938
2,115,676	April 26, 1938
2,118,352	May 24, 1938
2,118,977	May 31, 1938
2,129,727	Sept. 13, 1938
2,129,740	Sept. 13, 1938
2,137,123	Nov. 15, 1938
2,137,266	Nov. 22, 1938
2,137,318	Nov. 22, 1938
2,147,509	Feb. 14, 1939
2,148,604	Feb. 28, 1939
2,148,633	Feb. 28, 1939
2,150,044	Mar. 7, 1939
2,151,109	Mar. 21, 1939
2,152,470	Mar. 28, 1939
2,152,481	Mar. 28, 1939
2,152,482	Mar. 28, 1939
2,152,514	Mar. 28, 1939
2,152,515	Mar. 28, 1939
2,152,618	Mar. 28, 1939
2,153,857	Apr. 11, 1939
2,154,141	Apr. 11, 1939
2,154,907	April 18, 1939

Patent No.	*Issued*
2,156,137	April 25, 1939
2,159,240	May 23, 1939
2,163,234	June 20, 1939
2,165,468	July 11, 1939
Re. 21,153	July 18, 1939
2,166,522	July 18, 1939
2,167,134	July 25, 1939
2,167,135	July 25, 1939
2,167,136	July 25, 1939
2,167,137	July 25, 1939
2,167,400	July 25, 1939
2,167,405	July 25, 1939
2,168,193	Aug. 1, 1939
2,168,461	Aug. 8, 1939
2,168,874	Aug. 8, 1939
2,169,830	Aug. 15, 1939
2,169,831	Aug. 15, 1939
2,169,837	Aug. 15, 1939
2,169,838	Aug. 15, 1939
2,169,840	Aug. 15, 1939
Re. 21,176	Aug. 15, 1939
2,172,750	Sept. 12, 1939
2,172,858	Sept. 12, 1939
2,172,859	Sept. 12, 1939
2,173,084	Sept. 19, 1939
2,173,173	Sept. 19, 1939
2,173,234	Sept. 26, 1939
2,173,235	Sept. 26, 1939
Re. 21,222	Oct. 3, 1939
2,174,566	Oct. 3, 1939
2,174,580	Oct. 3, 1939
2,177,162	Oct. 24, 1939
2,177,688	Oct. 31, 1939
2,177,713	Oct. 31, 1939
2,177,761	Oct. 31, 1939
2,181,499	Nov. 28, 1939
2,182,329	Dec. 5, 1939
2,183,966	Dec. 19, 1939
2,183,980	Dec. 19, 1939
2,185,388	Jan. 2, 1940
2,185,389	Jan. 2, 1940

Patent No.	*Issued*
2,187,978	Jan. 23, 1940
2,188,498	Jan. 30, 1940
2,188,504	Jan. 30, 1940
2,188,658	Jan. 30, 1940
2,188,970	Feb. 6, 1940
2,189,287	Feb. 6, 1940
2,189,310	Feb. 6, 1940
2,189,848	Feb. 13, 1940
2,189,849	Feb. 13, 1940
2,190,816	Feb. 20, 1940
2,191,796	Feb. 27, 1940
2,192,971	Mar. 12, 1940
2,192,991	Mar. 12, 1940
2,194,292	Mar. 19, 1940
2,195,438	April 2, 1940
2,196,881	April 9, 1940
2,197,239	April 16, 1940
2,197,516	April 16, 1940
2,198,969	April 30, 1940
2,198,983	April 30, 1940
2,201,365	May 21, 1940
2,201,770	May 21, 1940
2,203,519	June 4, 1940
2,203,520	June 4, 1940
2,203,521	June 4, 1940
2,203,528	June 4, 1940
2,204,216	June 11, 1940
2,204,712	June 18, 1940
2,205,190	June 18, 1940
2,205,738	June 25, 1940
2,206,954	July 9, 1940
2,206,989	July 9, 1940
2,206,990	July 9, 1940
2,208,374	July 16, 1940
2,208,382	July 16, 1940
2,209,394	July 30, 1940
2,210,089	Aug. 6, 1940
2,211,352	Aug. 13, 1940
2,211,458	Aug. 13, 1940
2,211,718	Aug. 13, 1940
2,212,173	Aug. 20, 1940

Patent No.	*Issued*
2,212,420	Aug. 20, 1940
2,214,846	Sept. 17, 1940
2,214,847	Sept. 17, 1940
2,216,160	Oct. 1, 1940
2,216,874	Oct. 8, 1940
2,216,997	Oct. 8, 1940
2,216,998	Oct. 8, 1940
2,217,948	Oct. 15, 1940
2,217,957	Oct. 15, 1940
2,218,980	Oct. 22, 1940
2,221,015	Nov. 12, 1940
2,221,452	Nov. 12, 1940
2,221,665	Nov. 12, 1940
2,221,666	Nov. 12, 1940
2,222,387	Nov. 19, 1940
2,226,648	Dec. 31, 1940
2,226,706	Dec. 31, 1940
2,227,815	Jan. 7, 1941
Re. 21,691	Jan. 14, 1941
2,228,725	Jan. 14, 1941
2,230,284	Feb. 4, 1941
2,231,704	Feb. 11, 1941
2,231,829	Feb. 11, 1941
2,233,470	Mar. 4, 1941
2,235,131	Mar. 18, 1941
2,235,816	Mar. 25, 1941
2,235,817	Mar. 25, 1941
2,235,859	Mar. 25, 1941
2,236,364	Mar. 25, 1941

Application Serial No.	*Application Serial No.*
679,997	276,594
46,081	276,736
63,577	277,861
84,861	277,862
134,477	278,316
152,487	282,470
177,663	287,912
195,955	289,116
196,885	294,583
200,647	294,848
205,293	296,220
209,442	296,339
212,691	297,081
221,497	297,326
227,629	298,010
233,358	298,205
233,371	302,556
233,372	304,939
234,741	305,049
238,757	308,152
244,190	309,929
248,245	311,374
250,141	311,901
250,914	313,360
253,040	314,573
254,290	314,822
256,033	317,622
259,380	317,628
259,546	321,610
261,910	321,659
262,146	321,811
262,846	323,290
264,716	324,510
264,935	325,566
265,953	326,149

Application Serial No.
326,154
326,163
328,351
330,277
330,278
330,491
331,406
331,570
335,617
335,238
337,569
337,653
340,647
343,939
344,648
345,289
345,726
346,907
347,389
347,817
349,541
350,722
352,211
352,212

Application Serial No.
352,757
352,805
352,988
353,814
355,442
355,547
355,942
357,729
358,223
358,620
358,981
358,988
360,249
361,700
364,499
365,442
365,459
367,248
372,091
372,988
375,574
380,447
380,448

MICRO CARD
TRADE MARK ®

1673

MATTHEW BENDER & COMPANY MB 49

LATOUR CORPORATION

UNITED STATES LETTERS PATENT

Patent No.	*Issued*
1,507,725	Sept. 9, 1924
1,522,305	Jan. 6, 1925
1,524,645	Jan. 27, 1925
1,524,646	Jan. 27, 1925
1,545,502	July 14, 1925
1,563,754	Dec. 1, 1925
1,592,529	July 13, 1926
1,601,313	Sept. 28, 1926
Re. 16,461	Nov. 9, 1926
1,607,466	Nov. 16, 1926
1,607,467	Nov. 16, 1926
1,614,136	Jan. 11, 1927
1,615,808	Jan. 25, 1927
1,625,125	April 19, 1927
1,627,707	May 10, 1927
1,630,346	May 31, 1927
1,631,213	June 7, 1927
1,637,828	Aug. 2, 1927
1,643,075	Sept. 20, 1927
1,663,712	Mar. 27, 1928
1,669,059	May 8, 1928
1,673,009	June 12, 1928
1,687,253	Oct. 9, 1928
1,687,298	Oct. 9, 1928
1,710,170	April 23, 1929
1,791,965	Feb. 10, 1931
1,801,774	April 21, 1931
1,834,408	Dec. 1, 1931

ATWATER KENT MANUFACTURING COMPANY

United States Letters Patent and Applications

(Pursuant to rights acquired from Atwater Kent Manufacturing Company)

Patent No.	*Issued*
1,548,832	Aug. 11, 1925
1,639,042	Aug. 16, 1927
1,639,414	Aug. 16, 1927
1,646,471	Oct. 25, 1927
1,656,901	Jan. 24, 1928
1,666,480	April 17, 1928
1,672,123	June 5, 1928
1,672,493	June 5, 1928
1,689,948	Oct. 30, 1928
1,726,100	Aug. 27, 1929
1,738,575	Dec. 10, 1929
1,741,691	Dec. 31, 1929
1,749,423	Mar. 4, 1930
1,751,854	Mar. 25, 1930
1,755,310	April 22, 1930
1,760,506	May 27, 1930
1,767,837	June 24, 1930
1,771,127	July 22, 1930
1,771,381	July 22, 1930
1,777,500	Oct. 7, 1930
1,779,777	Oct. 28, 1930
1,787,732	Jan. 6, 1931
1,787,950	Jan. 6, 1931
1,790,165	Jan. 27, 1931
1,791,123	Feb. 3, 1931
1,795,090	Mar. 3, 1931
1,796,975	Mar. 17, 1931
1,810,355	June 16, 1931
1,812,349	June 30, 1931
1,814,270	July 14, 1931
1,814,774	July 14, 1931
1,819,299	Aug. 18, 1931
1,828,688	Oct. 20, 1931
1,829,015	Oct. 27, 1931

Patent No.	*Issued*
1,833,085	Nov. 24, 1931
1,835,801	Dec. 8, 1931
1,836,076	Dec. 15, 1931
1,846,616	Feb. 23, 1932
1,849,499	Mar. 15, 1932
1,850,105	Mar. 22, 1932
1,859,518	May 24, 1932
1,867,037	July 12, 1932
1,872,487	Aug. 16, 1932
1,885,301	Nov. 1, 1932
1,885,307	Nov. 1, 1932
1,886,571	Nov. 8, 1932
1,887,329	Nov. 8, 1932
1,888,430	Nov. 22, 1932
1,889,018	Nov. 29, 1932
1,890,426	Dec. 6, 1932
1,895,809	Jan. 31, 1933
1,896,825	Feb. 7, 1933
1,906,452	May 2, 1933
1,908,381	May 9, 1933
1,909,239	May 16, 1933
1,915,926	June 27, 1933
1,916,129	June 27, 1933
1,925,828	Sept. 5, 1933
1,926,173	Sept. 12, 1933
1,934,940	Nov. 14, 1933
1,960,599	May 29, 1934
1,966,805	July 17, 1934
1,971,497	Aug. 28, 1934
1,972,279	Sept. 4, 1934
1,973,293	Sept. 11, 1934
1,983,047	Dec. 4, 1934
1,986,641	Jan. 1, 1935
1,991,221	Feb. 12, 1935
2,001,076	May 14, 1935
2,021,321	Nov. 19, 1935

Application Serial No.
150,571
572,927

ZENITH RADIO CORPORATION

UNITED STATES LETTERS PATENT

(Pursuant to rights acquired from Zenith Radio Corporation)

Patent No.	*Issued*
1,521,380	Dec. 30, 1924
1,521,777	Jan. 6, 1925
1,522,136	Jan. 6, 1925
1,565,942	Dec. 15, 1925
1,571,964	Feb. 9, 1926
1,572,504	Feb. 9, 1926
1,588,248	June 8, 1926
1,589,979	June 22, 1926
1,590,198	June 29, 1926
1,590,635	June 29, 1926
1,591,417	July 6, 1926
1,617,452	Feb. 15, 1927
1,637,051	July 26, 1927
1,670,149	May 15, 1928
Re. 17,002	June 19, 1928
1,695,919	Dec. 18, 1928
1,697,778	Jan. 1, 1929
Re. 17,531	Dec. 17, 1929
1,772,077	Aug. 5, 1930
1,774,619	Sept. 2, 1930
1,806,796	May 26, 1931
1,828,529	Oct. 20, 1931
1,836,461	Dec. 15, 1931
1,906,106	Apr. 25, 1933

The license hereby granted under the foregoing patents listed under the heading "Zenith Radio Corporation" is granted pursuant to rights acquired from Zenith Radio Corporation by an agreement which limits the grant as follows:

1. Zenith Radio Corporation hereby grants to Hazeltine Corporation a personal, nondivisible, nontransferable and nonexclusive license to manufacture and to sell only for radio amateur reception,

radio experimental reception and radio broadcast reception throughout the United States, its territories and possessions, radio receivers so manufactured by Hazeltine Corporation under the United States Letters Patent which are listed on Exhibit "A", identified by the signatures of the President and Assistant Secretary of Zenith Radio Corporation attached to and made a part of this memorandum of agreement.

Zenith Radio Corporation further grants to Hazeltine Corporation the right to license all of its own licensees, present and future, under said Letters Patent, subject to the conditions hereinbefore set forth. In the event Hazeltine Corporation shall so license any of its own present or future licensees, Hazeltine Corporation shall furnish Zenith Radio Corporation with a list of all such licensees of Hazeltine Corporation, and will at all times keep said list up to date.

Nothing herein contained shall be considered as conveying any license, express or implied, by estoppel or otherwise, under any patent of Zenith Radio Corporation in countries foreign to the United States.

Zenith Radio Corporation shall have the right to terminate the licenses, rights and privileges herein granted upon the insolvency of Hazeltine Corporation or the appointment of a receiver for its property by giving Hazeltine Corporation notice of termination, such termination to take effect thirty (30) days after such notice. Such notice or notification must be in writing, and may be either by delivering the notice or notification to Hazeltine Corporation in any manner, or by mailing by registered mail such written notice or notification, properly addressed to Hazeltine Corporation's place of business last known to Zenith Radio Corporation. In the event that notice is given by mailing as herein provided, the time of notice shall be the time of mailing.

Bankruptcy of Hazeltine Corporation shall automatically terminate the licenses, rights and privileges herein granted to Hazeltine Corporation.

None of the rights or privileges under said Letters Patent hereinbefore granted to Hazeltine Corporation shall be, directly or indirectly, by operation of law or otherwise, assigned, transferred, divided or shared by Hazeltine Corporation with any person, firm or corporation whatsoever, without the written consent of Zenith Radio Corporation, except that, as hereinbefore provided, Hazeltine Corporation may license its own licensees, present and future, under said Letters Patent.

UNITED AMERICAN BOSCH CORPORATION

United States Letters Patent

(Pursuant to rights acquired from United American Bosch Corporation)

Patent No.	*Issued*
1,687,133	Oct. 9, 1928
1,702,926	Feb. 19, 1929
1,770,131	July 8, 1930
1,773,573	Aug. 19, 1930
1,792,822	Feb. 17, 1931
1,818,693	Aug. 11, 1931
1,856,774	May 3, 1932
1,877,228	Sept. 13, 1932
1,891,369	Dec. 20, 1932
1,898,835	Feb. 21, 1933
1,908,119	May 9, 1933
1,913,586	June 13, 1933
1,920,743	Aug. 1, 1933
1,944,687	Jan. 23, 1934
1,960,479	May 29, 1934

The license hereby granted under the foregoing patents listed under the heading "United American Bosch Corporation" is granted pursuant to rights acquired from United American Bosch Corporation by an agreement which limits the grant as follows:

"American Bosch further grants to Latour the right to grant to each of its own or Hazeltine Corporation licensees, present and future, a personal, non-divisible, non-transferable and non-exclusive license to manufacture and to sell only for radio amateur reception, radio experimental reception and radio broadcast reception throughout the United States, its Territories and Possessions, radio receivers manufactured under The Patents. Promptly upon the grant of the license to each licensee as aforesaid, Latour shall furnish American Bosch with the name and address of said licensee and will at all times keep such information up to date.

American Bosch further grants to Latour the right to grant, in connection with any license granted under the licensing power hereby conveyed, a full and complete release for all claims whatsoever of Amer-

ican Bosch against said licensee for past infringement of any Letters Patent included in such license, arising out of the manufacture, use or sale by said licensee of any radio apparatus and or parts designed by Latour or by its associated or controlling companies. No release shall be granted with respect to any device or arrangement not so designed by Latour or its associated or controlling companies, although some or all of the other apparatus with which said device or arrangement is used was so designed.

Nothing herein contained shall be considered as conveying any license, expressed or implied, by estoppel or otherwise, under any of The Patents in any country foreign to the United States.

American Bosch shall have the right to terminate the licenses, rights and privileges herein granted upon the insolvency of Latour or the appointment of a Receiver for its properties by giving Latour a notice of termination, said termination to take effect thirty (30) days after such notice, provided that such notice or notification is in writing and delivered in any manner or mailed by registered mail, properly addressed to Latour's place of business last known to American Bosch. In the event that notice is given by mailing as herein provided, the time of notice shall be the time of mailing.

Bankruptcy of Latour shall automatically terminate the licenses, rights and privileges herein granted to Latour.

None of the rights and privileges under The Patents hereinbefore granted to Latour shall be, directly or indirectly, by operation of law or otherwise, assigned, transferred, divided or shared by Latour with any person, firm or corporation whatsoever without the written consent of American Bosch, except that Latour may grant licenses and releases under said patents as hereinbefore provided."

MISCELLANEOUS UNITED STATES LETTERS PATENT

(Pursuant to limited rights acquired from their respective owners)

Patent No.	*Issued*
2,063,814	Dec. 8, 1936
2,089,270	Aug. 10, 1937
2,089,271	Aug. 10, 1937
2,146,068	Feb. 7, 1939
2,212,968	Aug. 27, 1940

Schedule B.

ADDITIONAL PATENT RIGHTS AND PRIVILEGES

Licensee is hereby notified that the Hazeltine Corporation and Latour Corporation have entered into an agreement with A. Atwater Kent and Atwater Kent Manufacturing Company whereby "A. Atwater Kent and Atwater Kent Manufacturing Company agree not to sue Hazeltine Corporation and/or Latour Corporation and/or the present and future licensees of said corporation and/or said licensees' distributors, jobbers, dealers, vendees, customers and/or users and/or any one acting by or under the authority of them or any of them, for infringement of letters patent relating to radio now owned or controlled by said Kent and of letters patent which may issue on applications for letters patent relating to radio now owned or controlled by said Kent, by reason of the design of radio apparatus by Hazeltine Corporation and/or Latour Corporation for manufacturers of radio apparatus or by reason of the manufacture, use and sale of radio apparatus and/or parts manufactured and sold by said Hazeltine Corporation and/or Latour Corporation and/or said licensees."

Licensor is informed that the following United States Letters Patent and applications for United States Letters Patent come within the terms of the foregoing agreement with A. Atwater Kent and Atwater Kent Manufacturing Company:

PATENTS OWNED OR CONTROLLED BY ARTHUR ATWATER KENT

Patent No.	*Issued*
1,445,324	Feb. 13, 1923
1,485,931	Mar. 4, 1924
1,514,322	Nov. 4, 1924
1,519,621	Dec. 16, 1924
1,523,832	Jan. 20, 1925
1,524,258	Jan. 27, 1925
1,534,267	Apr. 21, 1925
1,582,826	Apr. 27, 1926
1,583,071	May 4, 1926

Patent No.	*Issued*
1,583,105	May 4, 1926
1,583,471	May 4, 1926
1,587,136	June 1, 1926
1,588,474	June 15, 1926
1,597,901	Aug. 31, 1926
1,619,911	Mar. 7, 1927
1,650,754	Nov. 29, 1927
1,651,012	Nov. 29, 1927
1,655,372	Jan. 3, 1928
1,658,562	Feb. 7, 1928
1,668,117	May 1, 1928.
1,668,155	May 1, 1928
1,668,320	May 1, 1928.
1,673,461	June 12, 1928
1,679,310	July 31, 1928
1,683,012	Sept. 4, 1928
1,705,925	Mar. 19, 1929
1,710,482	Apr. 23, 1929
1,713,134	May 14, 1929
1,719,014	July 2, 1929
1,719,057	July 2, 1929
1,719,956	July 9, 1929
1,727,604	Sept. 10, 1929
1,730,010	Oct. 1, 1929
1,743,145	Jan. 14, 1930
1,757,719	May 6, 1930
1,775,399	Sept. 9, 1930
1,783,292	Dec. 2, 1930
1,794,855	Mar. 3, 1931
1,796,375	Mar. 17, 1931
1,829,007	Oct. 27, 1931
1,978,514	Oct. 30, 1934

HAZELTINE CORPORATION
15 EXCHANGE PLACE
JERSEY CITY, N. J.

September 18, 1942.

Automatic Radio Manufacturing Co., Inc.,
122 Brookline Ave.,
Boston, Mass.

Gentlemen:

In connection with the Hazeltine Standard License Agreement granted to your company as of September 1, 1342 and executed concurrently herewith, Hazeltine Corporation agrees that, during the period in which the manufacture of apparatus of the type licensed thereunder is suspended by Government action, if at the end of any fiscal license year the major portion of which falls within such period the royalties due and payable by your company for such fiscal year shall not have aggregated the minimum royalty payment of Ten Thousand Dollars ($10,000) due at that time under the provisions of Article IV, Section 4, of said Agreement, it will waive such minimum royalty payment for that year provided that your company shall have faithfully and fully performed all of its obligations under the Agreement.

Very truly yours,
HAZELTINE CORPORATION

By Jack Binns
President.

JB:lw

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HAZELTINE CORPORATION
15. EXCHANGE PLACE
JERSEY CITY, N. J.

September 15, 1942.

Automatic Radio Manufacturing Co., Inc.,
122 Brookline Ave.,
Boston, Mass.

Gentlemen:

This letter is written in connection with the Hazeltine Standard License Agreement granted to your Company as of September 1, 1942 and executed concurrently herewith, for the manufacture and sale of radio broadcast receivers and related apparatus and is to record a supplemental understanding between the parties reached in order more nearly to give effect to the intention of the parties with respect to the reduction in royalty rates specified in said Standard License Agreement relative to those specified in your previous Hazeltine License Agreement.

It is hereby agreed between the parties, effective as of September 1, 1942:

(1) For the purpose of royalty computation, there may be deducted from the sales price of combination radio-phonograph apparatus sold by your Company under said Standard License Agreement an amount equal to the excess of the cost of the cabinet plus a selling price mark-up of thirty-three and one-third per cent. (33-1/3%) over Twenty-Two and 50/100 Dollars ($22.50).

(2) In determining the selling price of apparatus identified in Article IV, Section 1, subsections (a) and (b), of the aforesaid License Agreement, upon which royalties are payable, there may be deducted from the actual selling price thereof, in addition to any deductions provided in said Section 1, an amount corresponding to licensee's manufacturing cost or purchase price of the mechanical portion of electric phonograph apparatus including automatic record-changing apparatus, if such be included, plus a selling price mark-up of thirty-three and one-third per cent. (33-1/3%). The term "manufacturing cost" as used herein shall be determined in accordance with the latest edition at the time of "Uniform Accounting Manual - Electrical Manufacturing Industry" issued by the National Electrical Manufacturers Association.

HAZELTINE CORPORATION
18 EXCHANGE PLACE
JERSEY CITY, N. J.

Automatic Radio Manufacturing Co., Inc.

This letter is written in duplicate and, upon acceptance by a duly authorized officer of your company, becomes a part of the aforesaid Hazeltine Standard License Agreement executed concurrently herewith.

Very truly yours,

HAZELTINE CORPORATION

By Jack Binns
President.

ATTEST:

Laurence B. Dodds
Assistant Secretary.

ACCEPTED:

AUTOMATIC RADIO MANUFACTURING CO., I

By Harold Huss

ATTEST:

John J. Grady Jr.

JB:lw

42

HAZELTINE CORPORATION
15 EXCHANGE PLACE
JERSEY CITY, N. J.

September 1, 1942.

Automatic Radio Manufacturing Co., Inc.,
122 Brookline Ave.,
Boston, Mass.

Gentlemen:

This letter is written in connection with the Hazeltine Standard License Agreement between your company as Licensee and Hazeltine Corporation as Licensor and executed concurrently herewith, and is to record the further following understandings between the parties:

1. The existing Hazeltine Standard License Agreement in the field of radio broadcast receivers issued to your company and dated as of October 1, 1937 is hereby terminated by mutual consent as of August 31, 1942.

2. Licensor waives its rights of inspection of your company's books and records relative to sales and royalty payments made by your company prior to September 1, 1942, and releases your company from any claim it may have for additional royalties on apparatus sold by your company prior thereto.

3. Your company hereby accepts the aforesaid Hazeltine Standard License Agreement executed concurrently herewith in full satisfaction and accord of any rights or claims of any nature whatsoever which it may have now or at any time in the future arising out of any prior license, agreement, or understanding between your company and Hazeltine Corporation or arising out of a certain Letter Agreement between Hazeltine Corporation and Radio Corporation of America dated December 15, 1937, by which Hazeltine Corporation undertook, upon the occurrence of certain events and the fulfillment of specified conditions, to grant to its licensees a new Hazeltine Standard License at reduced rates of royalty and your company hereby waives any right it may now or hereafter have to any further or other reductions in royalty rates in said License Agreement executed concurrently herewith or to any other or further License Agreement under the provisions of such Letter Agreement.

HAZELTINE CORPORATION
18 EXCHANGE PLACE
JERSEY CITY, N. J.

Automatic Radio Manufacturing Co., Inc.

This letter is written in duplicate and, upon acceptance by you, shall be taken in conjunction with and considered as a part of the aforesaid Hazeltine Standard License Agreement.

Very truly yours,

HAZELTINE CORPORATION

By Jack Binns
President.

ATTEST:

Laurence A. Hyde
Assistant Secretary.

ACCEPTED:

AUTOMATIC RADIO MANUFACTURING CO., IN

By Daniel McGinnis

ATTEST:

John J. Grady Secy

JB:lw

At the same term, on April 28, 1947, the following Answer was filed by defendant:

ANSWER.

[Filed April 28, 1947.]

1. Defendant is without knowledge or information sufficient to enable it to form a belief as to the truth of the allegations of paragraph 1 of the complaint.

2. Defendant admits the allegations of paragraph 2.

3. Defendant denies the allegations of paragraph 3.

4. Defendant admits that on or about September 18, 1942 it entered into an agreement in writing effective September 1, 1942, a copy of which is annexed to the complaint and marked Exhibit A.

5. Defendant admits that some of the terms and conditions of said agreement, Exhibit A, are correctly stated in paragraph 5 of the complaint but denies that it is now or ever was obligated to pay plaintiff "in any event" a minimum sum of ten thousand dollars ($10,000) for each year ending August 31; admits that Order No. L-265 of the War Production Board prohibited from on or about April 12, 1942 to on or about August 30, 1945 the manufacture for civilian use of all the types of apparatus specified in Section 2 of Article III of said agreement that defendant manufactured or was equipped to manufacture; and admits that defendant agreed to render to plaintiff monthly written statements of defendant's sales of such apparatus of the types specified in said Section 2 of Article III of said agreement that defendant might make and sell under the terms of said agreement, but avers that no such apparatus was made or sold by it between September 1, 1942 and the date of filing of the complaint herein.

6. Defendant admits that on or about August 30, 1945 said Order No. L-265 was revoked but is without knowledge or information sufficient to enable it to form a belief as to the truth of the other allegations of paragraph 6 of the complaint.

7. Defendant admits that since on or about August 30, 1945, to the date of filing of the complaint herein, defendant has been

engaged in the manufacture and sale of apparatus in the general nature of that outlined in said subsections (a) (c) and (d) of Section 2 of Article III of said agreement, but denies that any of said apparatus is covered by any of the patents set out in Schedules A and B, which form a part of said agreement of September 18, 1942; denies that defendant failed to pay to Hazeltine Corporation or plaintiff any monies due as royalty under said agreement and denies that it has failed or refused to render to said Hazeltine Corporation or plaintiff statements of any of defendant's sales that are required by said agreement and avers that the agents of Hazeltine Corporation or plaintiff were fully advised orally on several occasions during the years 1945, 1946 and 1947 at defendant's factory by defendant's president that no such statements were rendered Hazeltine Corporation or the plaintiff because defendant had neither made nor sold radio apparatus of any of the types covered by said agreement from September 1, 1942 to the dates of the several interviews with said agents.

8. Defendant is without knowledge or information sufficient to enable it to form a belief as to the truth of the allegations of paragraph 8 of the complaint.

Further answering, defendant avers:

9. That from the effective date of said agreement, to wit: September 1, 1942, to the date of the complaint herein, it has not made or sold radio apparatus of any type whatsoever covered by the claims of plaintiff's patents listed in Schedules A and B, which form a part of said agreement, Exhibit A; that from the effective date of said agreement, none of the radio apparatus made and sold by defendant has been marked with the license notice required by Section 2 of Article VI of said agreement for all licensed apparatus made and sold under said agreement; and that none of defendant's catalogs, circulars, or price lists includes the notation "Licensed Under Hazeltine Corporation Patents" required by Section 4 of Article VI for all apparatus to be sold under said agreement.

10. That the plaintiff, in an illegal endeavor to eliminate all competition and secure an unlawful monopoly in violation of the antitrust laws of the United States, acquired the approximately 425 United States letters patent and the approximately 120 applications for United States letters patent on and for alleged inventions listed in said Schedules A and B from its employees, from Latour Corporation; from Atwater Kent Manufacturing Company; from Zenith Radio Corporation; from United American Bosch Corporation; from certain others not named in said Schedules (page 32 of said agreement) and from Arthur Atwater Kent; and hence plaintiff is not entitled to the aid of this Court in maintaining this action.

11. That prior to the effective date of the license, Exhibit A, and at all times from and after said date, defendant has been and now is licensed under the United States letters patent and applications for United States letters patent owned or controlled by the Radio Corporation of America, exceeding, so defendant is advised, about five thousand (5,000) in number, and that plaintiff's radio apparatus of the types specified in subsections (a) (c) and (d) of Section 2 of Article III of said agreement, Exhibit A, embodies the inventions disclosed in some of the patents and applications of the Radio Corporation of America under which it is licensed and in some of the patents owned by defendant, and does not embody any of the elements or combinations of elements or methods or modes of procedure recited in any of the claims of the patents or patent applications listed in said schedules A and B, and that defendant has performed all of the obligations under its license agreement with said Radio Corporation of America by it to be performed.

12. On information and belief, that many of the patents listed in said Schedules A and B are for small, narrow and unimportant improvements on the radio circuits and systems disclosed and claimed in the patents of the Radio Corporation of America under which defendant is licensed and are neither desirable nor essential to the production of merchantable radio receiving sets of the types

specified in subsections (a), (c) and (d) of Section 2 of Article III of said agreement.

13. On information and belief, that many of the patents listed in Schedules A and B accompanying the agreement, Exhibit A, had expired prior to September 1, 1942; that many others prior to said date had been held invalid by the United States District Courts, the Cirtuit Courts of Appeals, and the Supreme Court of the United States; that, prior to said date, many of the applications listed in Schedule A accompanying said agreement had become abandoned, and that many of Hazeltine Corporation's and plaintiff's licensees have long since ignored their respective license agreements with Hazeltine Corporation and plaintiff.

Wherefore, defendant prays that the complaint be dismissed with costs.

AUTOMATIC RADIO
MANUFACTURING COMPANY, INC.,
by GEO. K. WOODWORTH,
Its Attorney,
19 Congress Street,
Boston 9, Mass.

On the same day, defendant filed the following Interrogatories:

DEFENDANT'S INTERROGATORIES TO PLAINTIFF.

[Filed April 28, 1947.]

Defendant propounds the following interrogatories to be answered under oath by any officer of the plaintiff corporation having knowledge, or who may acquire knowledge, of the facts concerning which inquiry is made.

1. Which of the fifteen (15) models of radio apparatus of the type listed in Section 2 or Article III of the agreement, Exhibit A, annexed to the complaint, which were made by defendant since September 1, 1942 are claimed by plaintiff to embody the alleged inventions of the patents listed in Schedules A and B accompanying said agreement, respectively?

2. If any of said fifteen (15) models are claimed by plaintiff

to embody the alleged inventions of the patents listed in answer to interrogatory 1, state by number the claim or claims of each of said patents which are claimed by plaintiff to specify the elements or combinations of elements or the methods or modes of procedure that are embodied or employed in each of said models, respectively.

3. Have any of the applications listed on pages 24, 25, and 28, of Schedule A accompanying said agreement matured into letters patent?

4. If the answer to interrogatory 3 is "Yes" state the patent numbers and the respective issue dates of such patents.

5. If, in answer to interrogatory 4, patents are identified by their numbers and their respective issue dates, which of the fifteen (15) models of radio apparatus of the type listed in Section 2 of Article III of the agreement, Exhibit A, annexed to the complaint, which were made by defendant since September 1, 1942 are claimed by plaintiff to embody the alleged inventions of the patents stated in answer to said interrogatory 4, respectively.

6. If any of said fifteen (15) models are claimed by plaintiff to embody the alleged inventions of the patents listed in answer to interrogatory 4, or any of them, state by number the claim or claims of each of said patents which are claimed by plaintiff to specify the elements or combinations of elements or the methods or modes of procedure that are embodied or employed in each of said models, respectively.

7. Have any of the applications listed on pages 24, 25, and 28, of Schedule A accompanying said agreement become abandoned?

8. If the answer to interrogatory 7 is "Yes," identify said applications by their respective serial numbers.

AUTOMATIC RADIO
MANUFACTURING COMPANY, INC.,
by GEO. K. WOODWORTH,
Its Attorney,
19 Congress Street,
Boston 9, Massachusetts.

A copy of the foregoing interrogatories to plaintiff was served on plaintiff's counsel by leaving the same at the office of Roberts, Cushman & Grover, 31 Milk Street, Boston 9, Massachusetts, this twenty-eighth day of April, 1947.

GEO. K. WOODWORTH.

At the same term, on May 27, 1947, the plaintiff filed the following Answers to Defendant's Interrogatories:

PLAINTIFF'S ANSWERS TO INTERROGATORIES PROPOUNDED BY DEFENDANT.

[Filed May 27, 1947.]

Plaintiff, Hazeltine Research, Inc., by Laurence B. Dodds, its Executive Vice-President, voluntarily answers as follows defendant's Interrogatories served on plaintiff's attorney April 28, 1947, with answers to Interrogatories Nos. 1, 2, 5 and 6 directed solely to defendant's broadcast receivers Models Nos. C-60X, 601-602, 611, 612X, 614X-616X, 620, 640, 660, 670, 677, 720, F-790, and A.T.T.P., which said models have been represented by defendant to plaintiff as constituting all the models of radio apparatus of the type listed in Section 2 of Article III of the license agreement, filed with the complaint herein and identified as Exhibit A, which have been made by defendant since September 1, 1942, and with answers to said Interrogatories Nos. 1, 2, 5 and 6 based solely upon the schematic circuit diagrams for said models, photostat copies of which are attached hereto and marked Exhibits B through N, respectively, which said diagrams have been furnished or referenced by defendant to plaintiff for plaintiff's use in answering said Interrogatories and have been represented by defendant as accurately representing said models:

1. In answer to Interrogatory No. 1, the following models of radio apparatus of the type listed in Section 2 of Article III of the license agreement, filed with the complaint herein and identified as Exhibit A, made by defendant since September 1, 1942, embody the inventions of one or more of the patents owned by

plaintiff and listed in Schedules A and B of said agreement: C-60X, 601-602, 611, 612X, 614X-616X, 620, 640, 660, 670, 677, 720, F-790, and A.T.T.P.

2. In answer to Interrogatory No. 2, the following models of radio apparatus referred to in the foregoing answer to Interrogatory No. 1 come within at least the claim or claims of the patents referred to in the foregoing answer to Interrogatory No. 1, as specified below:

(a)

Model Nos.	Patent Nos.	Claims
C-60X)	1,958,027	3, 15 and 17
601-602)	2,015,327	All claims
611)	2,041,291	18 and 20
612X)	1,951,685	1, 2, 3, 5, 6, and 8
614X-616X)	2,041,273	All claims
620)		
640)		
660)		
670)		
677)		
720)		
F-790)		
A.T.T.P.)		

(b) In addition to the patents and claims enumerated in paragraph (a) above:

Model Nos.	Patent Nos.	Claims
601-602)	Re. 19,765	5, 14, and 20
611)		
612X)		
614X-616X)		
640)		
670)		
677)		
F-790)		

(c) In addition to the patents and claims enumerated in paragraph (a) above:

Model Nos.	Patent Nos.	Claims
660	1,913,604	1, 6, and 7
	2,022,514	2, 5, 11, 16, and 22
	2,021,692	7 and 8
	Re. 20,400	19, 22, and 25

3. Yes.

4. The patent applications listed in Schedule A of aforesaid license agreement filed with the complaint herein and identified as Exhibit A which have matured into United States Letters Patents with the respective numbers and dates of issue thereof are as follows:

Serial No.	Patent No.	Issue Date
679,997	2,278,159	Mar. 31, 1942
46,081	2,255,690	Sept. 9, 1941
63,577	2,262,707	Nov. 11, 1941
84,861	2,255,050	Sept. 9, 1941
134,477	2,261,762	Nov. 4, 1941
152,487	2,246,172	June 17, 1941
177,663	2,249,532	July 15, 1941
195,955	2,240,533	May 6, 1941
200,647	2,313,952	Mar. 16, 1943
205,295	2,243,599	May 27, 1941
209,442	2,239,136	Apr. 22, 1941
212,691	2,254,435	Sept. 2, 1941
221,497	2,249,533	July 15, 1941
227,629	2,247,512	July 1, 1941
233,358	2,240,593	May 6, 1941
233,371	2,240,507	May 6, 1941
233,372	2,240,490	May 6, 1941
234,741	2,240,534	May 6, 1941
238,757	2,242,934	May 20, 1941
244,190	2,259,538	Oct. 21, 1941

Serial No.	Patent No.	Issue Date
248,245	2,242,952	May 20, 1941
250,141	2,240,700	May 6, 1941
250,914	2,255,691	Sept. 9, 1941
253,040	2,255,692	Sept. 9, 1941
254,290	2,273,709	Feb. 17, 1942
256,033	2,250,170	July 22, 1941
259,380	2,253,312	Aug. 19, 1941
259,546	2,239,776	Apr. 29, 1941
261,910	2,259,520	Oct. 21, 1941
262,146	2,416,424	Feb. 25, 1947
262,846	2,252,599)	Aug. 12, 1941)
	Re.22,390)	Nov. 9, 1943)
264,716	2,264,781	Dec. 2, 1941
264,935	2,255,403	Sept. 9, 1941
265,953	Re.22,195	Oct. 6, 1942
276,594	2,269,540	Jan. 13, 1942
276,736	2,258,370	Oct. 7, 1941
277,861	2,251,966	Aug. 12, 1941
277,862	2,279,543	Apr. 14, 1942
278,316	2,254,114	Aug. 26, 1941
282,470	2,254,721	Sept. 2, 1941
287,912	2,269,590	Jan. 13, 1942
289,116	2,253,313	Aug. 19, 1941
294,583	2,261,800	Nov. 4, 1941
294,848	2,264,782	Dec. 2, 1941
296,220	2,253,355	Aug. 19, 1941
296,339	2,253,338	Aug. 19, 1941
297,081	2,247,898	July 1, 1941
297,326	2,280,191	Apr. 21, 1942
302,556	2,271,181	Jan. 27, 1942
304,939	2,269,524	Jan. 13, 1942
305,049	2,291,277	July 28, 1942
308,152	2,251,929	Aug. 12, 1941
311,374	2,291,450	July 28, 1942

Serial No.	Patent No.	Issue Date
311,901	2,245,710	June 17, 1941
313,360	2,247,538	July 1, 1941
314,573	2,304,091	Dec. 8, 1942
317,622	2,302,619	Nov. 17, 1942
317,628	2,293,233	Aug. 18, 1942
321,610	2,257,092	Sept. 30, 1941
321,659	2,255,839	Sept. 16, 1941
321,811	2,269,570	Jan. 13, 1942
324,510	2,300,082	Oct. 27, 1942
325,566	2,284,131	May 26, 1942
326,149	2,294,182	Aug. 25, 1942
326,154	2,271,964	Feb. 3, 1942
326,163	2,308,375	Jan. 12, 1943
328,351	2,271,322	Jan. 27, 1942
330,277	2,292,765	Aug. 11, 1942
330,278	2,270,539	Jan. 20, 1942
331,406	2,309,852	Feb. 2, 1943
335,617	Re.21,826	June 17, 1941
335,238	2,263,825	Nov. 25, 1941
337,569	2,277,192	Mar. 24, 1942
337,653	2,271,203	Jan. 27, 1942
340,647	2,303,184	Nov. 24, 1942
343,939	2,251,397	Aug. 5, 1941
344,648	2,280,187	Apr. 21, 1942
345,289	2,280,181	Apr. 21, 1942
345,726	2,250,862	July 29, 1941
346,907	2,289,948	July 14, 1942
347,389	2,295,038)	Sept. 8, 1942
	Re.22,275)	Feb. 23, 1943
347,817	2,265,848	Dec. 9, 1941
349,541	2,290,517	July 21, 1942
350,722	2,285,938	June 2, 1942
352,211	2,265,826	Dec. 9, 1941
352,757	2,277,850	Mar. 31, 1942

Serial No.	Patent No.	Issue Date
352,805	2,273,163	Feb. 17, 1942
355,442	2,252,148	Aug. 12, 1941
355,942	2,295,816	Sept. 15, 1942
357,729	2,300,451	Nov. 3, 1942
358,223	2,294,328	Aug. 25, 1942
358,620	2,264,018	Nov. 25, 1941
358,981	2,401,481	June 4, 1946
358,988	2,263,667	Nov. 25, 1941
360,249	2,283,106	May 12, 1942
361,700	2,300,452	Nov. 3, 1942
364,499	2,343,561	Mar. 7, 1944
365,442	2,276,488	Mar. 17, 1942
365,459	2,264,019)	Nov. 25, 1941
	Re.22,302)	Apr. 20, 1943
367,248	2,284,219	May 26, 1942
372,091	2,300,942	Nov. 3, 1942
375,574	2,280,139	Apr. 21, 1942
380,447	2,305,842	Dec. 22, 1942
380,448	2,303,987	Dec. 1, 1942

5. In answer to Interrogatory No. 5, the following model of radio apparatus referred to in the foregoing answer to Interrogatory No. 1 embodies the inventions of one or more of the patents enumerated in the foregoing answer to Interrogatory No. 4: Model A.T.T.P.

6. In answer to Interrogatory No. 6, the following model of radio apparatus referred to in the foregoing answer to Interrogatory No. 1 comes within at least the claim or claims of the patents enumerated in the foregoing answer to Interrogatory No. 4, as specified below:

Model No.	Patent No.	Claims
A.T.T.P.	Re. 22,195	1, 2, 3, 10, 11, 12, 13 and 14

7. Yes.

8. The following, of the applications listed in Schedule A of aforesaid license agreement filed with the complaint herein and identified as Exhibit A, have become abandoned:

Serial No.	Serial No.
196,885	330,491
298,010	331,570
298,205	352,212
309,929	352,988
314,822	353,814

LAURENCE B. DODDS.

STATE OF NEW YORK
COUNTY OF NEW YORK, ss:

On this twenty-third day of May, 1947, there personally appeared before me, a Notary Public in and for the County and State aforesaid, Laurence B. Dodds, who, being duly sworn, deposed and said that he is executive vice-president of Hazeltine Research, Inc., plaintiff in the above-entitled action, and that the foregoing answers subscribed to by him are true to the best of his information and belief.

PEGGY COYLE,
Notary Public.

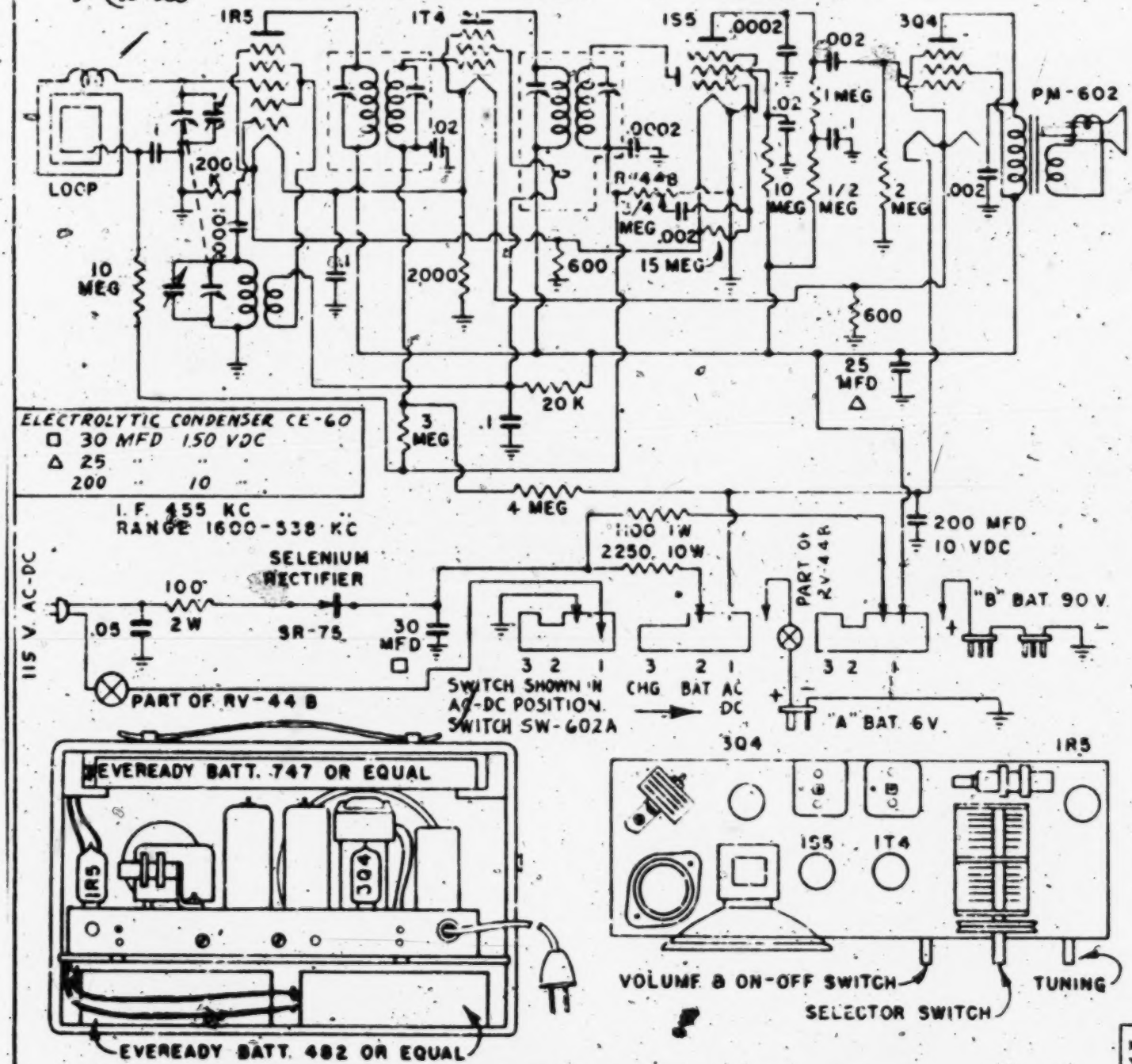
[SEAL]

Commission Expires March 30, 1948

I hereby certify that service of the above plaintiff's answers to interrogatories propounded by defendant has been made this twenty-seventh day of May, 1947 by my delivering in hand to George K. Woodworth, attorney of record for the defendant, a copy thereof.

JOHN D. WOODBERRY.

Automatic Radio MODEL NO. C-60X

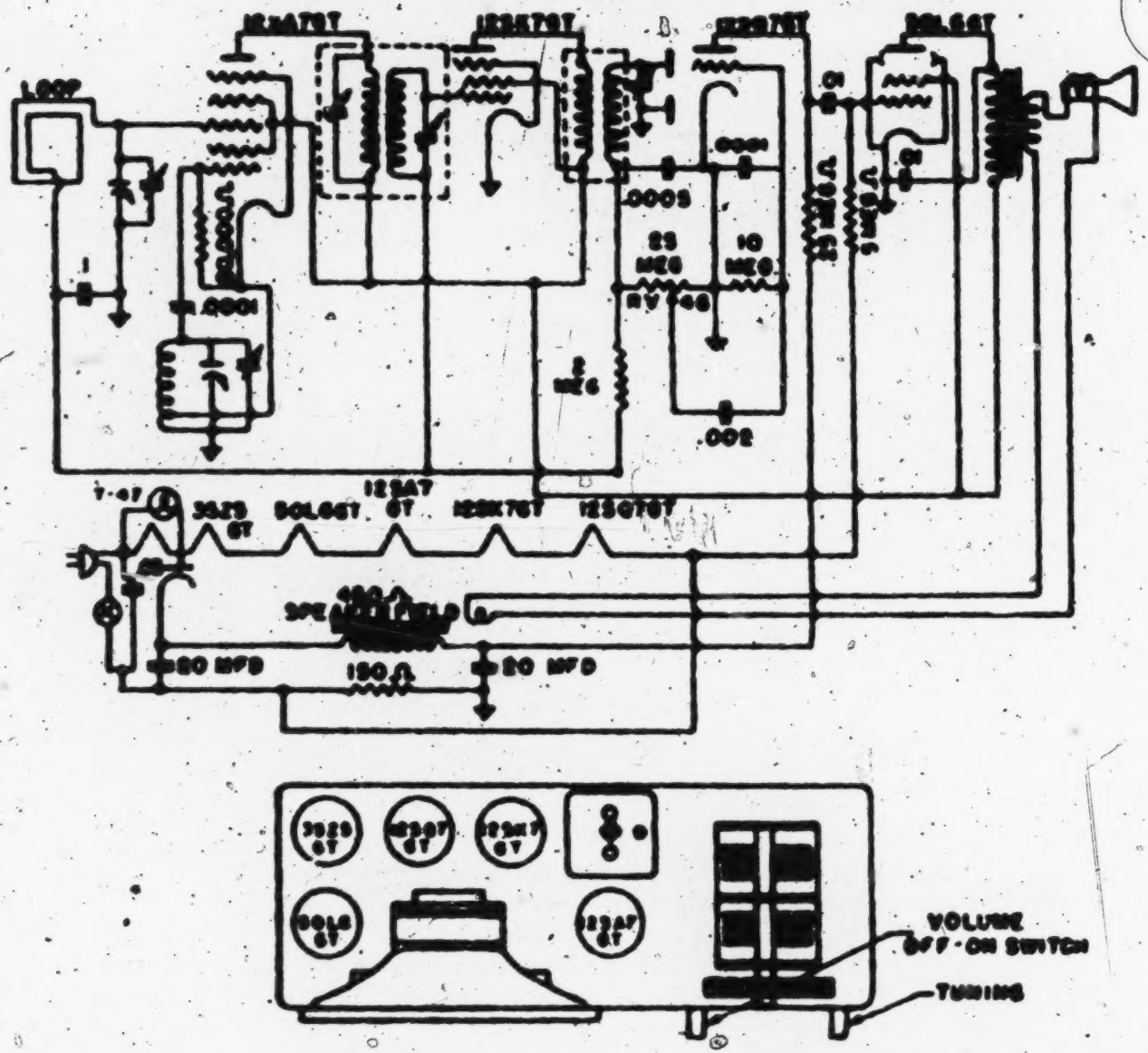


AUTOMATIC RADIO MFG. CO., INC.

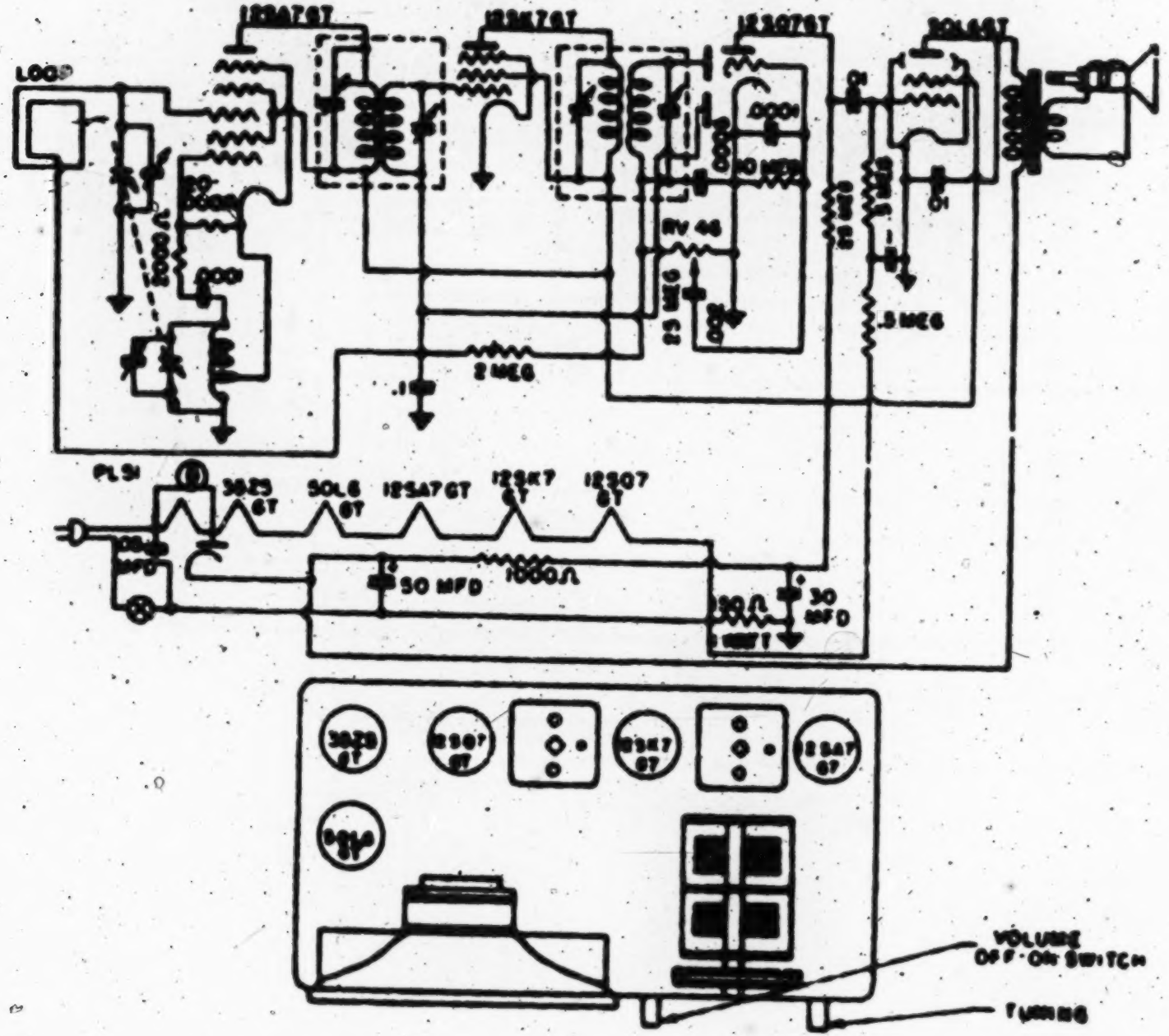
122 BROOKLINE AVE. BOSTON, 15, MASS.

13SMF-147

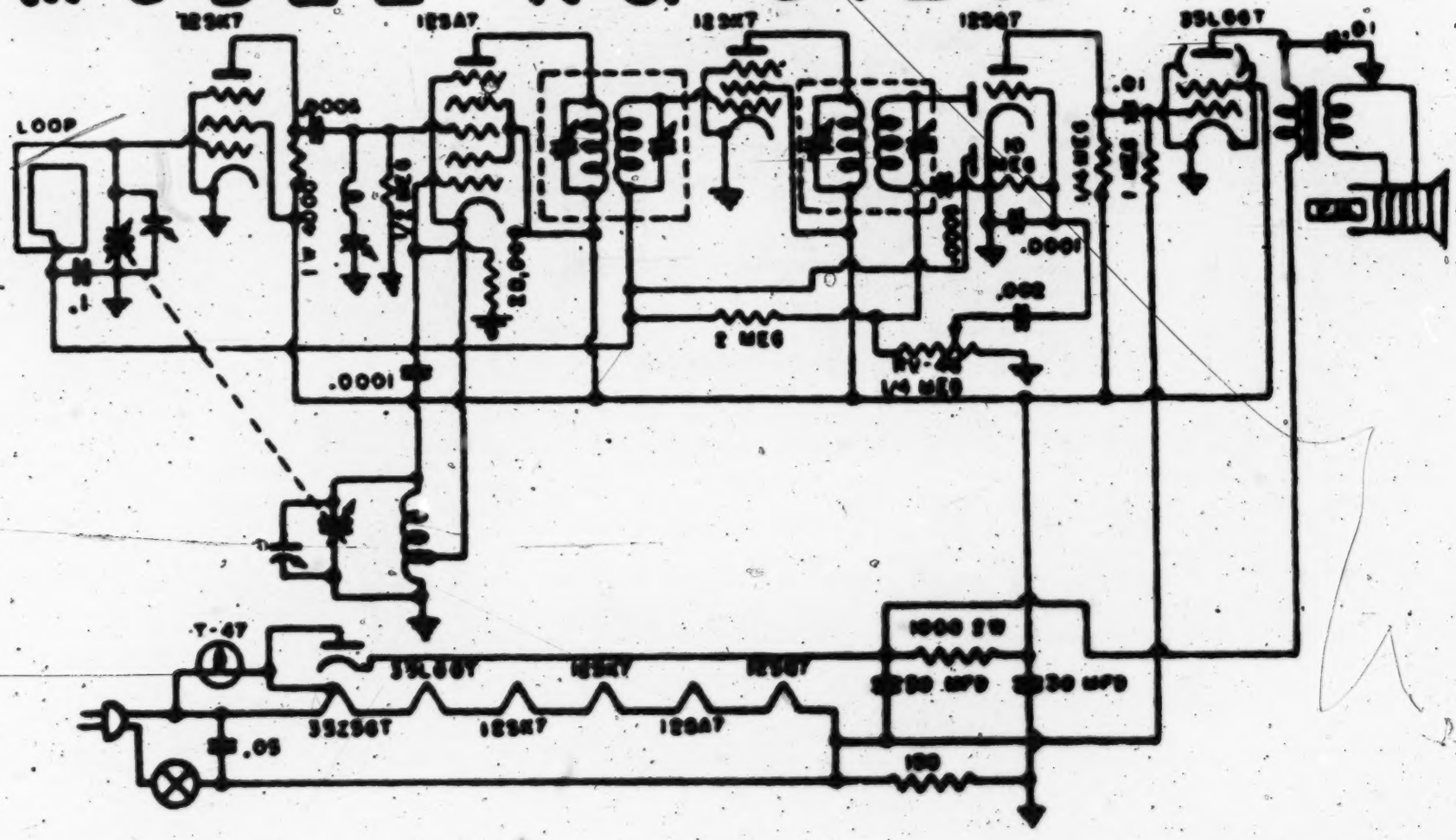
Automatic Radio 601-602

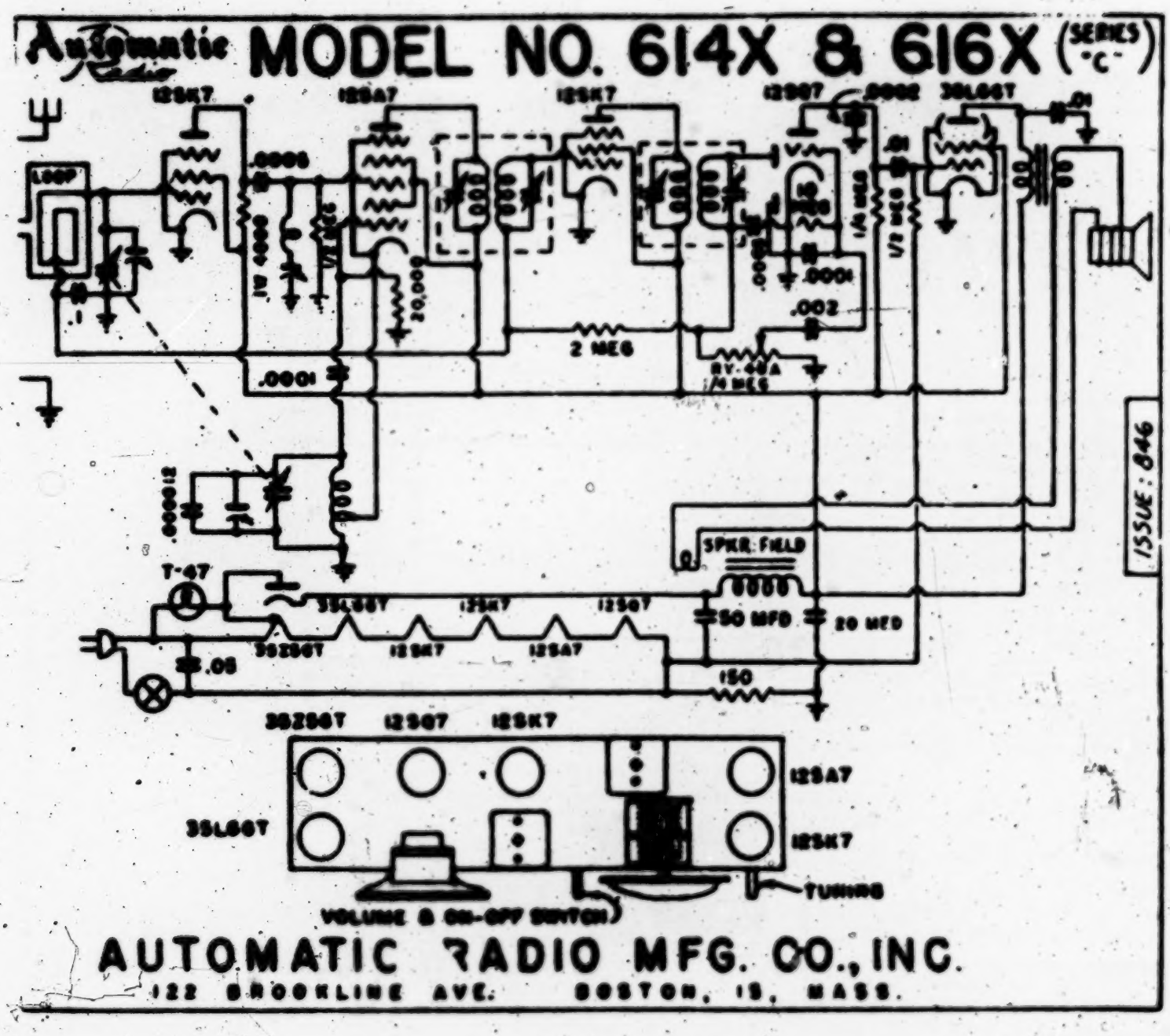


Automatic Radio Model 611

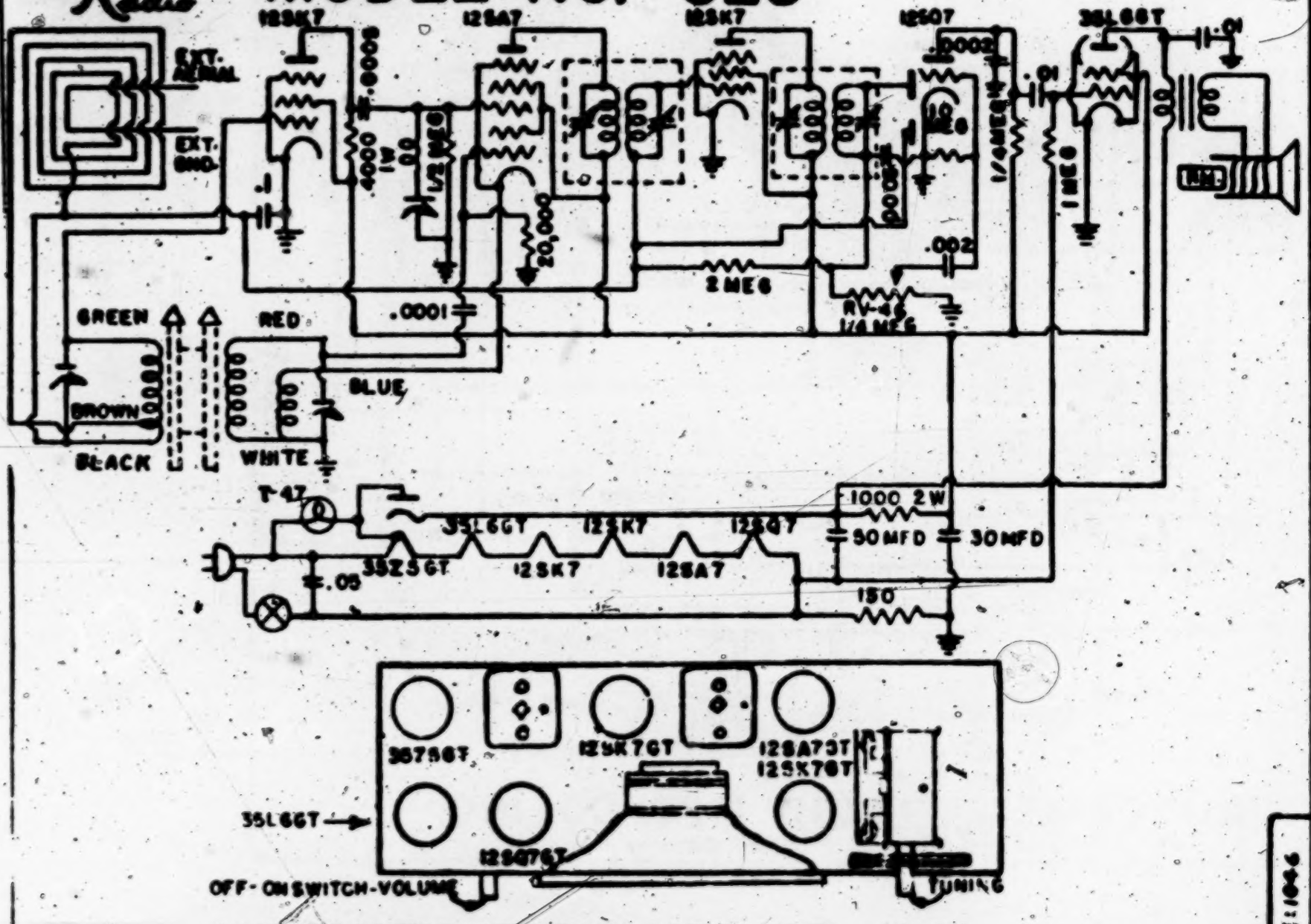


MODEL NO. 612X




Automatic
MODEL NO. 614X & 616X (SERIES "C")
12SK7
12SA7
12SK7
12SQ7
35L6GT
.01
LOOP
.0005
.0001
.002
2 MEG
.00025
.0001
SPKR. FIELD
T-47
35L6GT
12SK7
12SQ7
50 MFD
20 MFD
35Z5GT
12SK7
12SA7
.05
150
35Z5GT
12SQ7
12SK7
12SA7
35L6GT
12SK7
TUNING
VOLUME & ON-OFF SWITCH
ISSUE: 846
AUTOMATIC RADIO MFG. CO., INC.
122 BROOKLINE AVE. BOSTON, 15, MASS.

Automatic Radio MODEL NO. 620

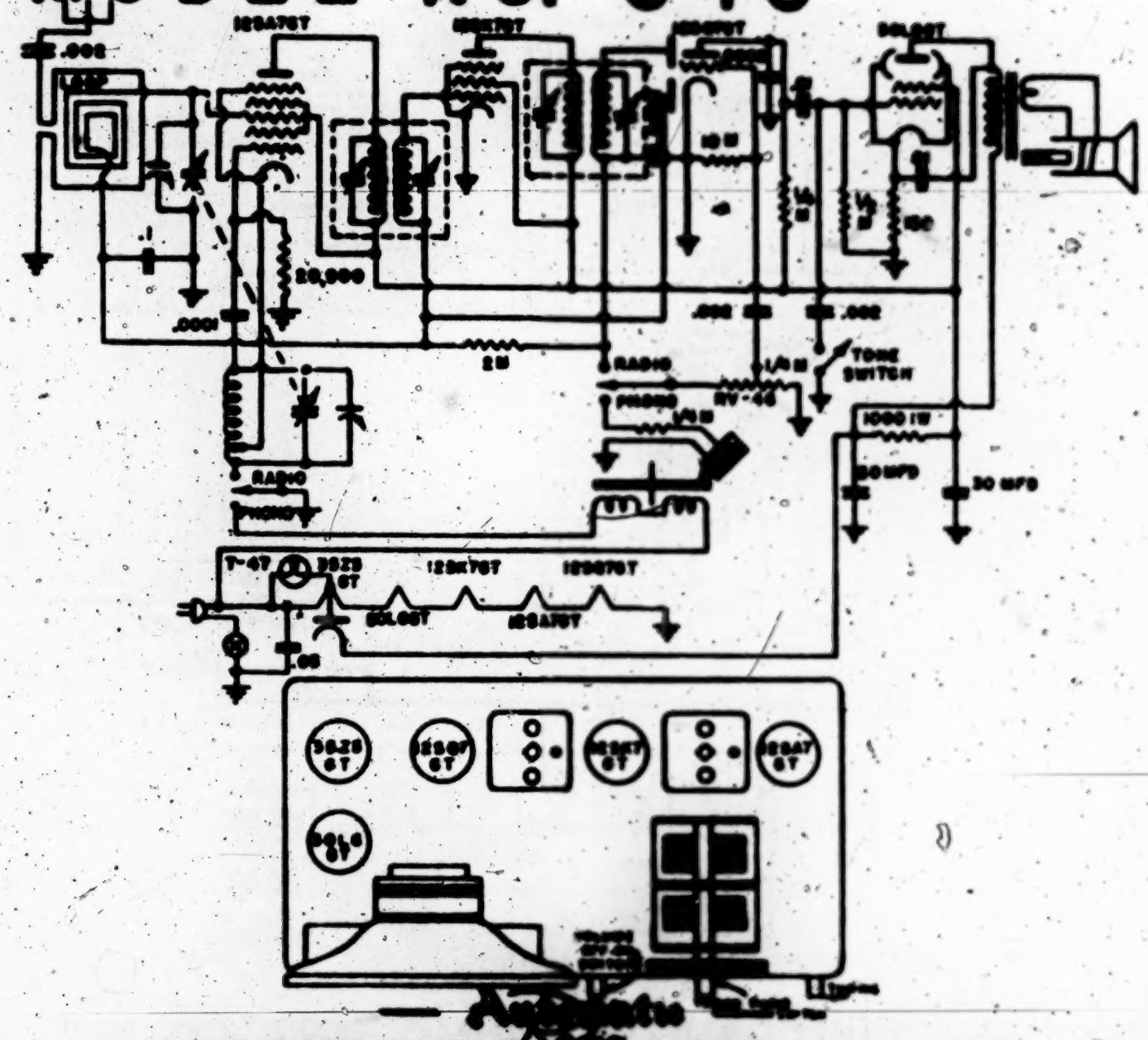


AUTOMATIC RADIO MFG. CO., INC.

122 BROOKLINE AVE. BOSTON, 15, MASS.

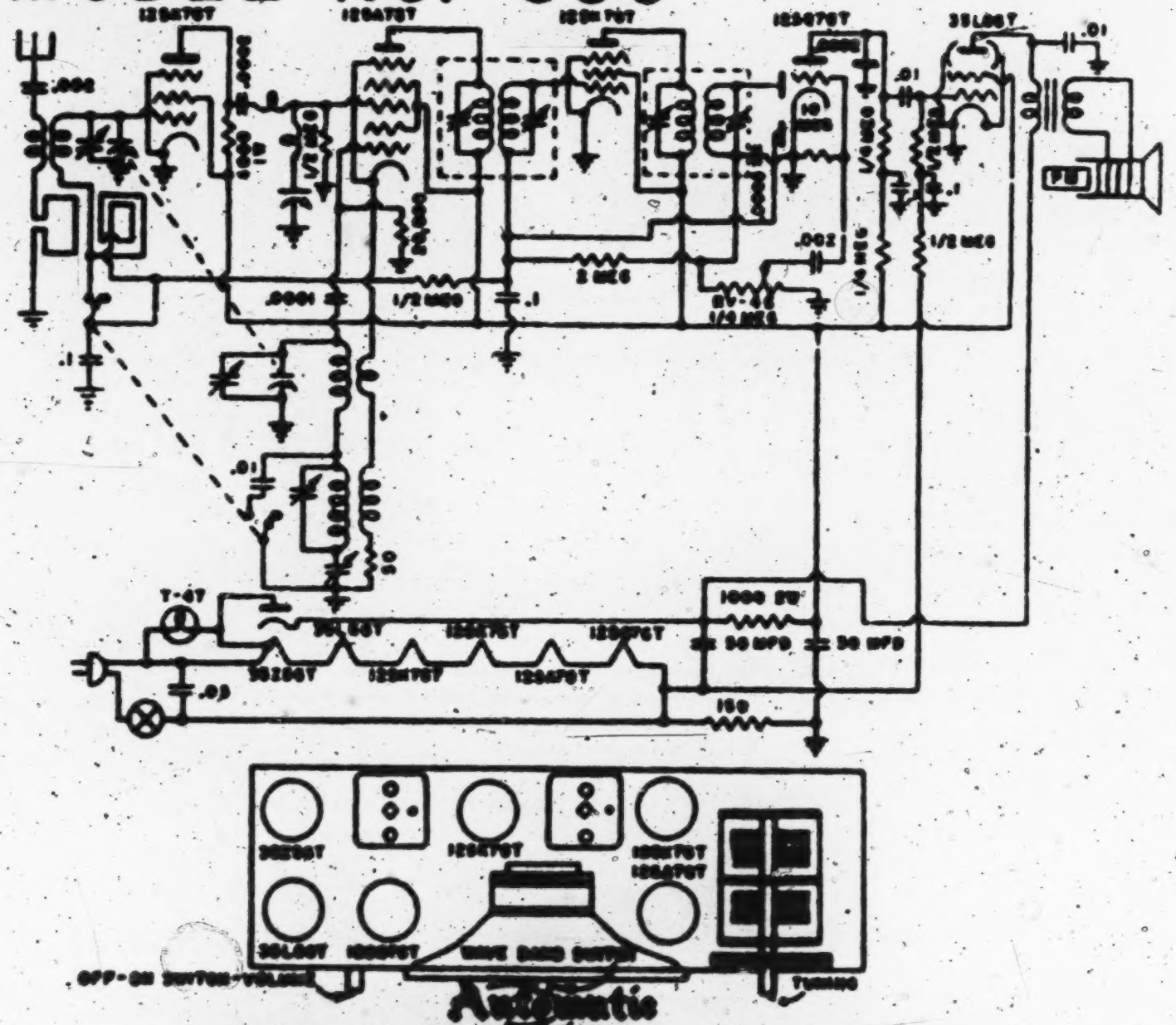
ISSUE: 1046

MODEL NO. 640



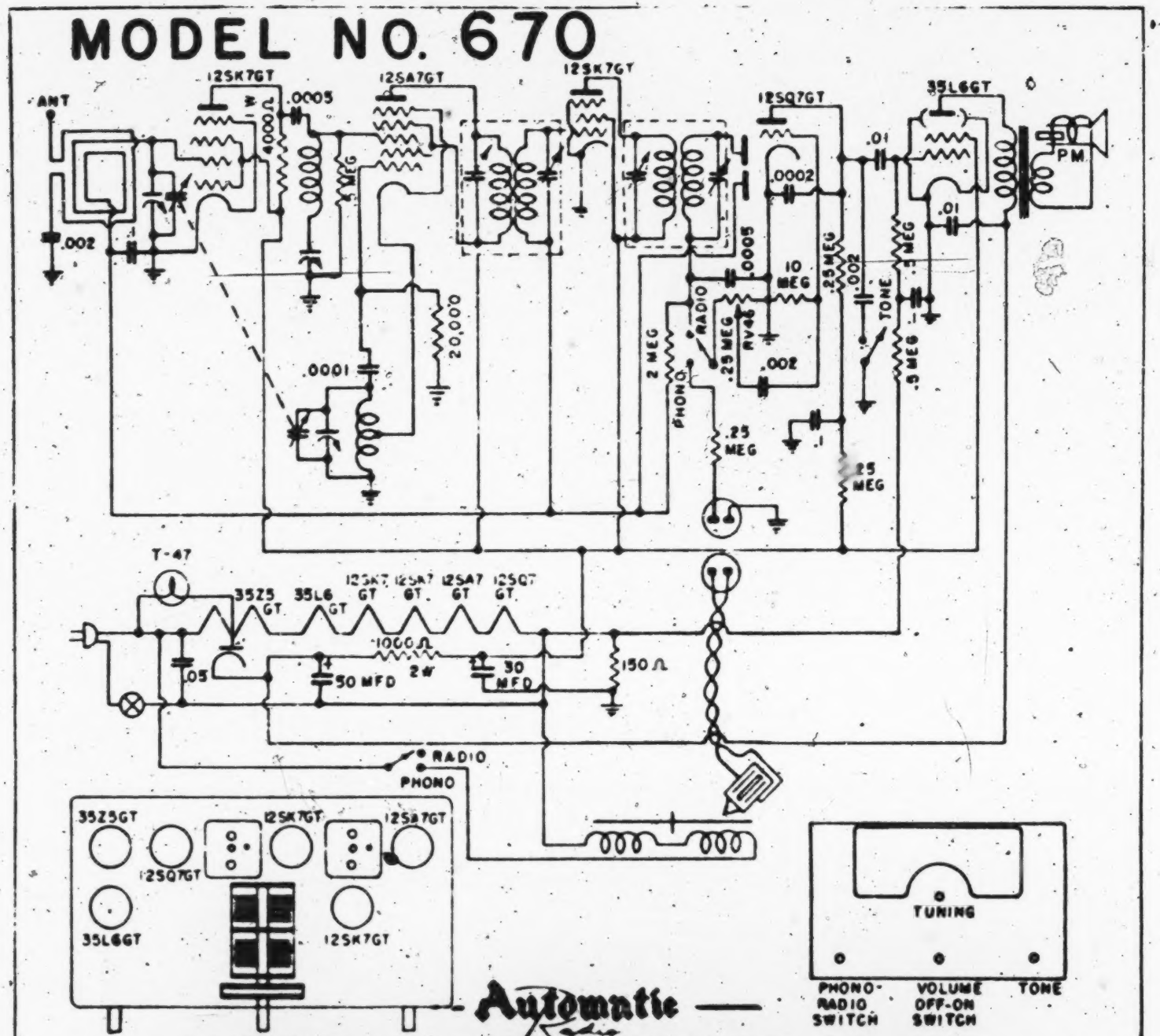
AUTOMATIC RADIO MFG. CO., INC.
122 BROOKLINE AVE., BOSTON, 15, MASS.
COMPILED BY M. N. BEITMAN, SUPREME PUBLICATIONS

MODEL NO. 660



AUTOMATIC RADIO MFG. CO., INC.
122 BROOKLINE AVE., BOSTON. 15, MASS.

MODEL NO. 670



Automatic

AUTOMATIC RADIO MFG. CO., INC.

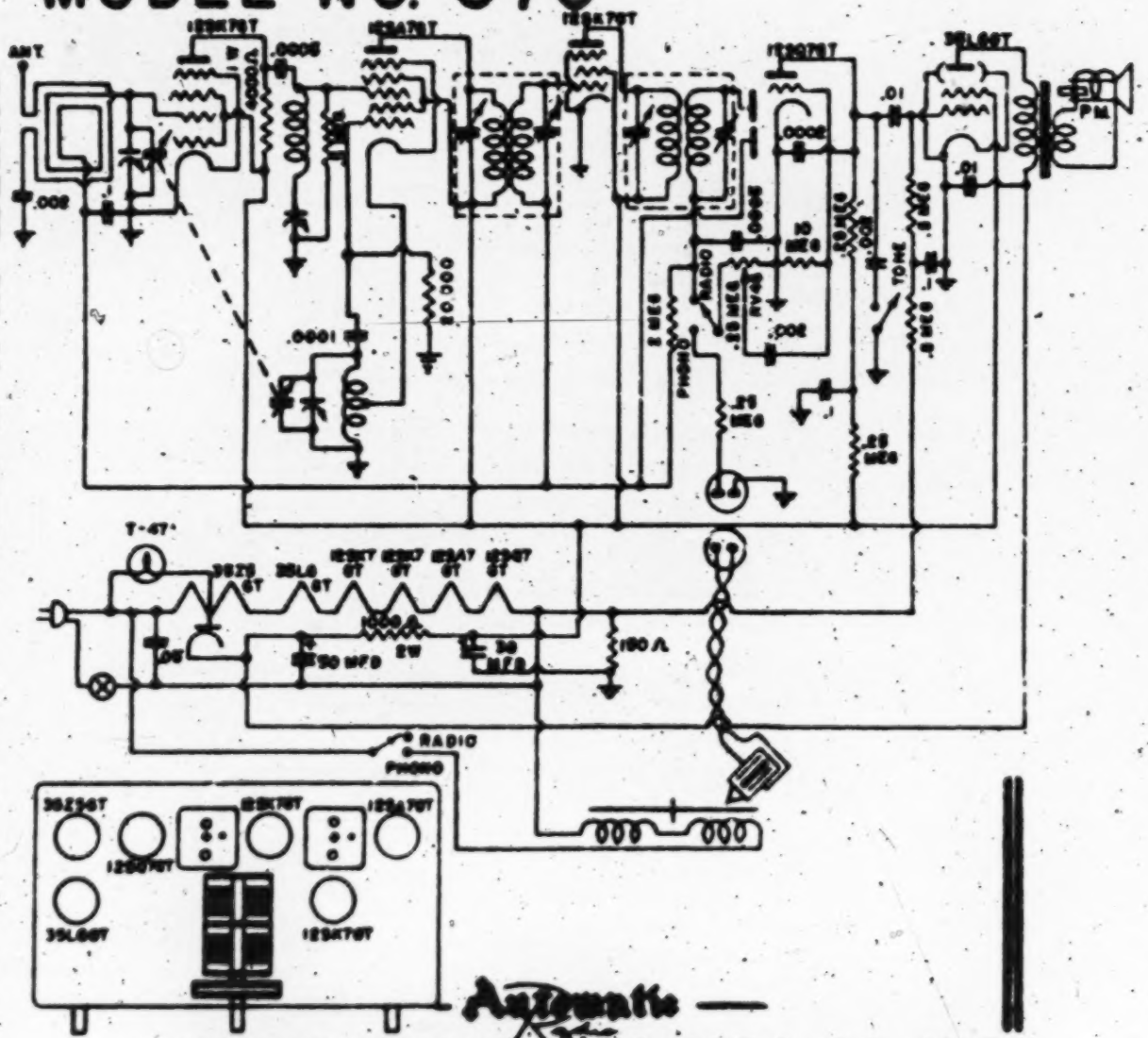
122 BROOKLINE AVE., BOSTON, 15, MASS.

RMA NO. _____

81

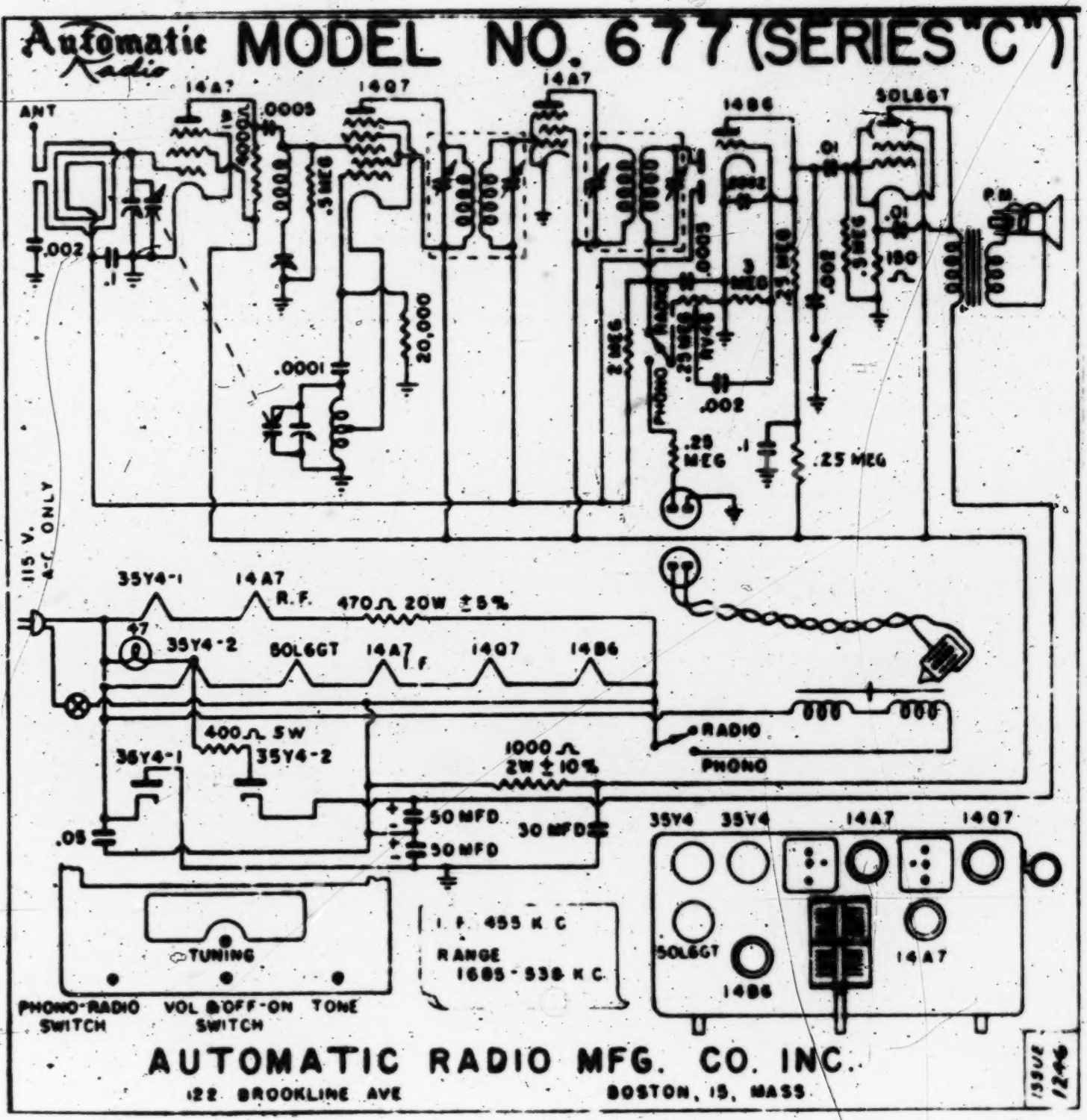
— Automatic —
AUTOMATIC RADIO MFG. CO. INC.
122 BROOKLINE AVE., BOSTON, 15, MASS.

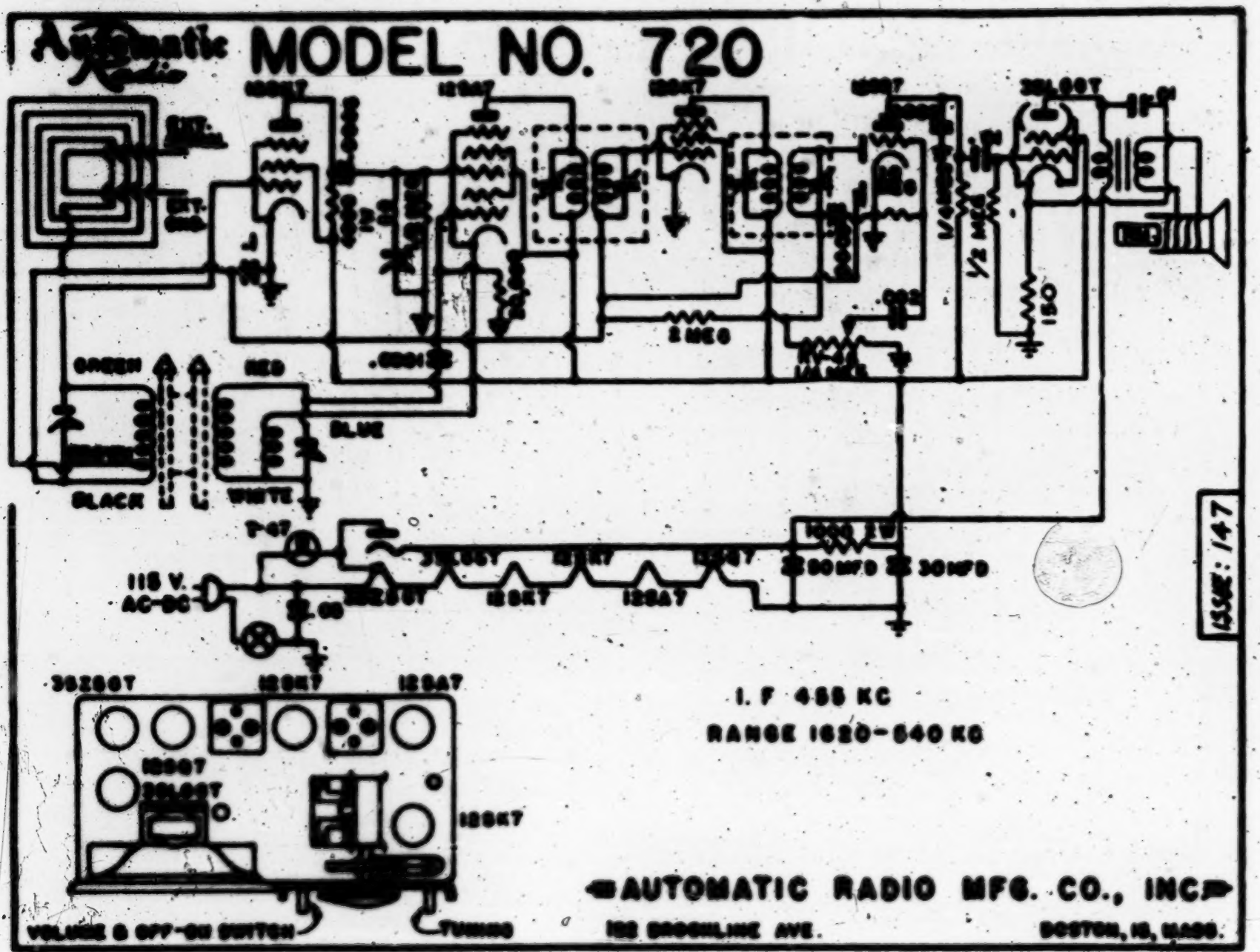
MODEL NO. 670



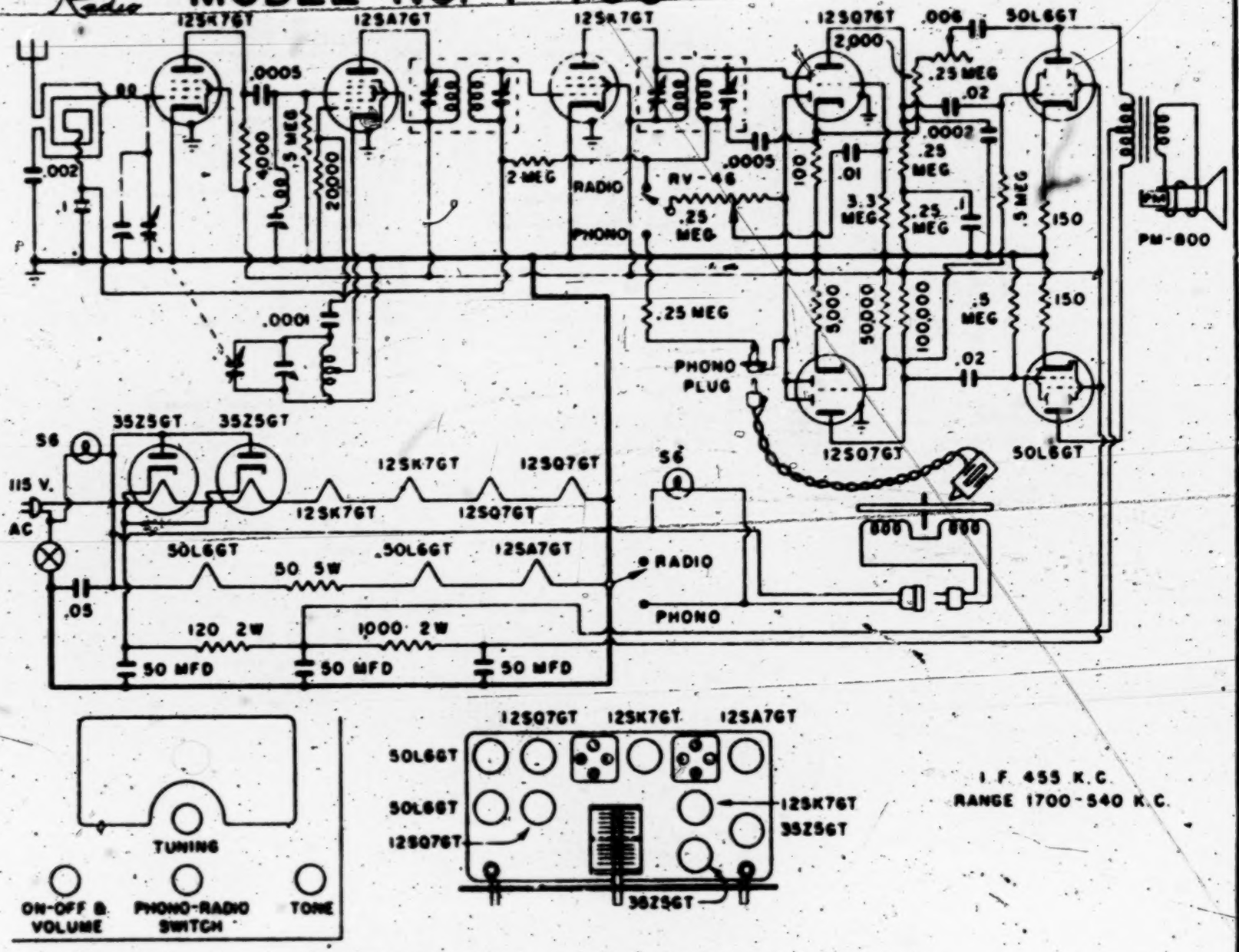
COMPILED BY M. N. BEITMAN, SUPREME PUBLICATIONS

— Automatic —
AUTOMATIC RADIO MFG. CO., INC.
122 BROOKLINE AVE., BOSTON, 15, MASS.


Automatic Radio
MODEL NO. 677 (SERIES "C")
ANT
14A7
1407
14A7
1486
50L6GT
.002
.1
.0005
.3MEG
.0001
20,000
2 MEG
.25 MEG
.01
150
P.M.
115 V. A-C ONLY
35Y4-1
14A7
R.F.
470Ω 20W ±5%
47
35Y4-2
50L6GT
14A7
I.F.
1407
1486
400Ω 5W
1000Ω 2W ±10%
RADIO
PHONO
50 MFD
30 MFD
50 MFD
.05
TUNING
I. F. 455 K.C.
RANGE
1685 - 538 K.C.
PHONO-RADIO SWITCH
VOL & OFF-ON SWITCH
TONE
AUTOMATIC RADIO MFG. CO. INC.
122 BROOKLINE AVE
BOSTON, 15, MASS


Automatic
MODEL NO. 720
GREEN
RED
BLUE
BLACK
WHITE
115 V.
AC-DC
1.F 455 KC
RANGE 1620-540 KC
AUTOMATIC RADIO MFG. CO., INC.
ISSUE: 147

Automatic Radio MODEL NO. F-790

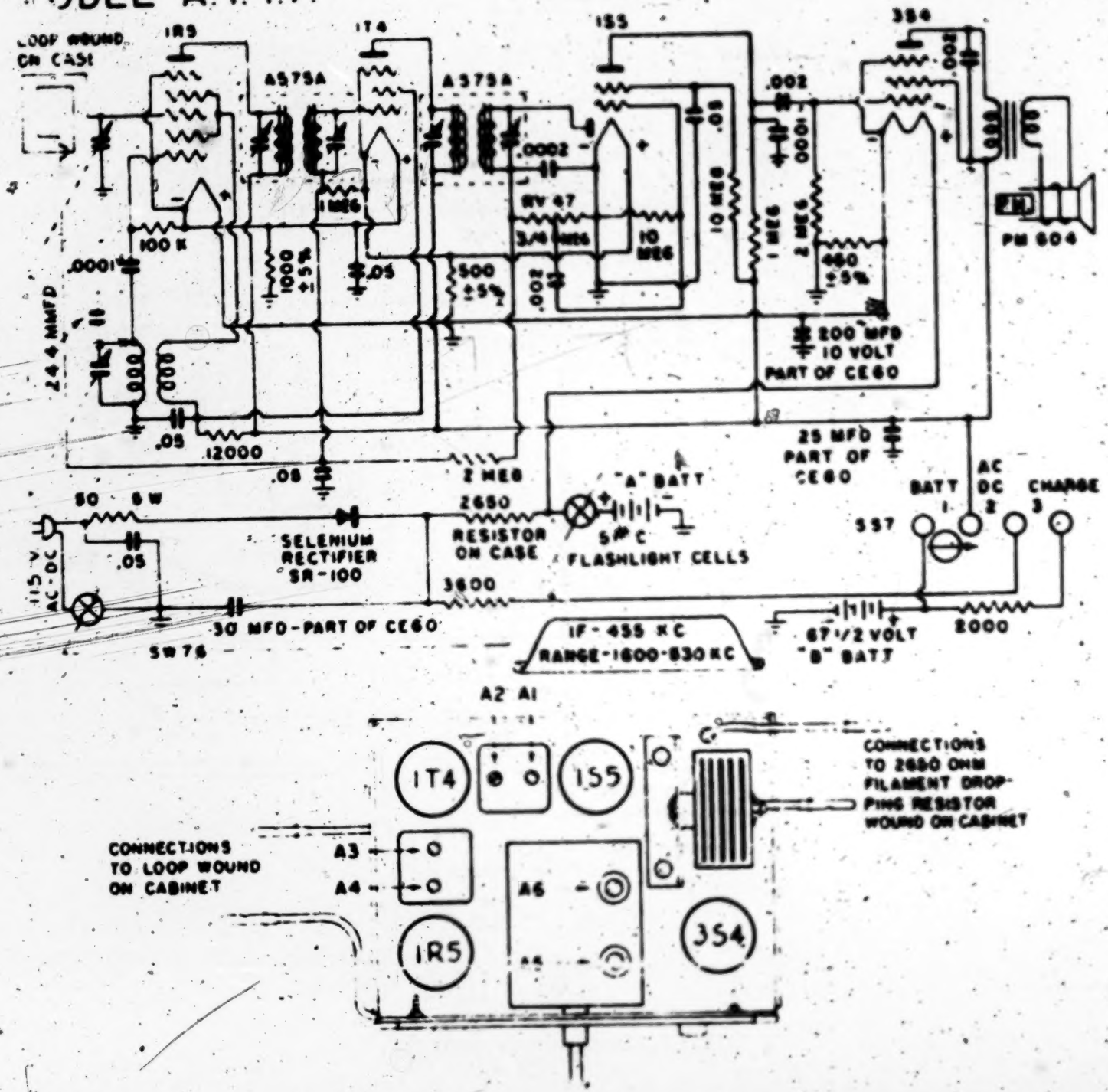


AUTOMATIC RADIO MFG. CO., INC.

122 BROOKLINE AVE

BOSTON, 15, MASS.

MODEL A.T.T.P.


LOOP WOUND ON CASE
1R5
1T4
A575A
A575A
1S5
3S4
.002
.0002
.0001
100 K
.0001
.05
.05
.12000
.08
500 ±5%
.002
.05
1 MEG
.05
8V 47
3/4 WATT
10 MEG
10 MEG
10 MEG
.002
.0001
.05
.002
460 ±5%
200 MFD 10 VOLT PART OF CE60
25 MFD PART OF CE60
PM 604
2 MEG
"A" BATT
5 #C FLASHLIGHT CELLS
50 5W
.05
SELENIUM RECTIFIER SR-100
2650 RESISTOR ON CASE
3600
115 V AC-DC
SW 76
30 MFD - PART OF CE60
IF - 455 KC
RANGE - 1600-830 KC
BATT 1
AC DC 2
CHARGE 3
SS7
67 1/2 VOLT "B" BATT
2000
A2 A1
1T4
1S5
1R5
3S4
A3
A4
A6
A5
CONNECTIONS TO LOOP WOUND ON CABINET
CONNECTIONS TO 2650 OHM FILAMENT DROPPING RESISTOR WOUND ON CABINET

The cause was then continued from term to term to the September Term, 1947, when on September 30, 1947, the defendant filed the following Motion to Amend Its Answer:

MOTION BY DEFENDANT TO AMEND ITS ANSWER.

[Filed September 30, 1947.]

Now comes defendant, by its attorney, and upon the annexed affidavit of David Housman moves to amend its answer in the following respects:

1. By the addition of Paragraph 14, as follows:

"14. Further answering the complaint, defendant, on information and belief, alleges that defendant was induced to enter into the said agreement in writing of September 18, 1942, through the fraud, misrepresentation and concealment of material facts by plaintiff, in that a number of the patents enumerated in Schedule A thereof which induced defendant to sign said agreement were represented by plaintiff to be valid and enforceable whereas, as a matter of fact, said patents had been adjudicated to be invalid by United States Courts, including the Supreme Court of the United States, which fact was concealed from defendant by plaintiff."

2. By the addition of Paragraph 15, as follows:

"15. That if the said agreement of September 18, 1942 was a valid and enforceable license agreement under patent rights of plaintiff, defendant has been evicted of its license by the adjudication by United States Courts of the invalidity of the patents which induced defendant to enter into the said agreement, whereby the said agreement is not enforceable against defendant, and is void for failure of consideration."

3. By the addition of Paragraph 16, as follows:

"16. Further answering the complaint, defendant, on information and belief, alleges that plaintiff has waived the minimum royalty provisions of the said agreement referred

to in Paragraph 5 of the said complaint, whereby plaintiff is not entitled to the relief prayed for with respect thereto."

AUTOMATIC RADIO MANUFACTURING COMPANY, INC.,

By GEO. K. WOODWORTH,

Its Attorney.

Dated September 30, 1947.

AFFIDAVIT

COUNTY OF SUFFOLK,

STATE OF MASSACHUSETTS, ss:

David Housman, being first duly sworn, deposes and says as follows:

I am an officer of Automatic Radio Manufacturing Company, Inc., defendant in the above entitled cause.

When I was induced to accept the license under the patents of Hazeltine Corporation I was primarily concerned with patents represented to me to be owned by the Hazeltine Corporation covering subject matter known by various technical names which my company desired to use in the radio receivers it manufactured and sold. The said patents were included among those listed in Schedule A attached to and forming part of the license agreement. These patents were all represented to me as outstanding with presumption of validity and presumed enforceability.

Recently in consulting additional counsel particularly familiar with patents relating to radio circuits and equipment, and particularly with the patents of Hazeltine Corporation, I found to my surprise that at the time I was induced to acquire the patent license the principal patents with which I was concerned had been held to be invalid, the most important of all of them by the Supreme Court of the United States, which facts were not made known to me. Specifically, and having in mind that the license agreement was executed as of September 1, 1942:

Letters Patent No. 1,648,088, according to my information and

belief, was held invalid on September 14, 1931, as reported in 52 F. (2d) 504; and also in 79 F. (2d) 238 on August 16, 1935;

Letters Patent No. 1,710,035 was held invalid on July 29, 1942, as reported in 129 F. (2d) 580;

Letters Patent No. 1,755,114 was held invalid on August 16, 1935, as reported in 79 F. (2d) 238;

Letters Patent No. 1,755,115 was held invalid on August 16, 1935, as reported in 79 F. (2d) 238;

Letters Patent No. 1,913,604 was held invalid on August 28, 1942, and on a petition for rehearing counsel for Hazeltine stated in open court that the effect of the decision of non-infringement was to invalidate the patent because, as limited by the court, it would be inapplicable to any practical equipment (130 F. (2d) 344);

Reissue Patent No. 19,744 was invalidated by the Supreme Court of the United States on May 12, 1941, as reported in 313 U.S. 259.

Additionally, since the date of the agreement the remaining Hazeltine patents of any materiality to the radio receivers that my company makes and desires to continue to make have been held invalid whereby my company has thus been effectively evicted from its license under the only patents which induced my company to accept a license. These patents are as follows:

Patent No. 2,111,483 held invalid on October 19, 1942, as reported in 131 F. (2d) 34;

Patent No. 1,951,685 held invalid on June 23, 1947, as reported in 72 F. Supp. 138;

Patent No. 2,041,273 held invalid on June 23, 1947, as reported in 72 F. Supp. 138.

To the best of my information and belief the Hazeltine Corporation has not received favorable adjudication of any patents affecting or alleged to affect the radio receivers manufactured by my company.

Additionally I recently learned, upon consulting with counsel, that Hazeltine Corporation by its actions and by unrestrained dis-

semination of information has waived, with respect to all of its licensees, the minimum royalty provision of its license agreements and notoriously has never enforced said provision with respect to any of its licensees and notoriously has advised its licensees and all others interested that it would not enforce or seek to enforce that provision of its license agreements.

Since the foregoing facts were made known to me I instructed counsel to take appropriate and prompt steps to amend the pleadings in this cause so as to present these matters by way of defense in this action.

DAVID HOUSMAN.

Sworn to and subscribed before me this thirtieth day of September, 1947.

Margaret B. Budden,
Notary Public.

[SEAL]

At the same term, on October 30, 1947, the following Stipulation *re* defendant's motion to amend its answer was filed:

STIPULATION.

[Filed October 30, 1947.]

It is stipulated and agreed by and between counsel, that defendant's Motion, filed on or about September 30, 1947 to amend its answer, may be allowed, the Honorable Court approving.

RICHARD F. WALKER,
Attorney for Plaintiff, without waiver of all proper objections to the affidavit of David Housman verified September 30, 1947, which is annexed to said Motion, and without admitting the truth of the allegations contained therein.

GEO. K. WOODWORTH,
Attorney for Defendant.

The stipulation is hereby approved and the motion allowed.

ARTHUR D. HEALEY,
United States District Judge.

On the same day, the foregoing stipulation was approved, and the defendant's motion to amend its answer was allowed by the court, the Honorable Arthur D. Healey, District Judge, sitting.

At the same term, on November 7, 1947, the following Stipulation *re* certain of defendant's models was filed:

STIPULATION.

[Filed November 7, 1947.]

Defendant represents that in addition to its models of radio broadcast receiving sets heretofore disclosed to plaintiff, in connection with its interrogatories to plaintiff filed in April, 1947, as constituting its prior production, defendant also produced and sold through at least parts of the calendar year of 1946 models designated as Nos. 662 and 666, which sets were identical in interior apparatus and circuit arrangements with defendant's set designated as Model No. 660, and differed from said Model No. 660 only in the container cabinets; wherefore it is stipulated that in and in connection with plaintiff's answers to defendant's said interrogatories as previously filed herein, Model No. "660" shall be treated and read as "660, 662 and 666".

RICHARD F. WALKER,
Attorney for Plaintiff.

GEO. K. WOODWORTH,
Attorney for Defendant.

Boston, Massachusetts
October 28, 1947

At the same term, on November 10, 1947, the following Motion for Summary Judgment was filed by the plaintiff:

PLAINTIFF'S MOTION FOR SUMMARY JUDGMENT.

[Filed November 10, 1947.]

Now comes plaintiff, under the provisions of Rule 56 of the Rules of Civil Procedure, and moves for entry of a summary judgment that defendant is indebted to plaintiff for minimum royalty as alleged and demanded in the complaint and, subject to credit for such minimum royalty, is further indebted to plaintiff for the specified royalty in an amount constituting 1.05% of its selling price of all radio broadcast receivers sold by defendant since September 1, 1942, and further providing that, on the sole issue of the amount of recovery due plaintiff from defendant as royalty according to such adjudication, this action be placed on the trial calendar for trial, or, in the alternative, be referred to a Master.

This motion is made on the grounds that there is no genuine issue as to any material fact necessary to support this motion except as to the extent of defendant's said sales, wherefore plaintiff is entitled to such summary judgment as a matter of law.

In support of this motion, plaintiff relies upon:

(a) The complaint herein;

(b) The license agreement between the parties, copy of which was filed with said complaint as Exhibit A, which provides for the payment of royalties on all radio broadcast receivers manufactured and sold by defendant and for certain minimum annual royalties;

(c) Defendant's answer as amended;

(d) Motion by defendant to amend its answer, and without any admission of the truth of its allegations, the affidavit of David Housman annexed thereto;

(e) Plaintiff's answers to defendant's Interrogatories together with Exhibits B through N thereto annexed; and

(f) The affidavits, together with the documentary exhibits an-

nexed thereto, of John R. Binns, John K. Gowen, Jr., and Harold A. Wheeler which are filed herewith.

Respectfully submitted,

CLARENCE H. PORTER,
ROBERTS, CUSHMAN & GROVER,
Attorneys for Plaintiff.

LAURENCE B. DODDS,
Of Counsel.

Due and sufficient notice of a copy of the foregoing Motion, together with copies of the affidavits filed in support thereof, is hereby acknowledged this tenth day of November, 1947.

GEO. K. WOODWORTH,
Attorney for Defendant.

On the same day, the following Affidavits annexed to plaintiff's motion for summary judgments were filed:

AFFIDAVIT OF JOHN K. GOWEN, JR.

[Filed November 10, 1947.]

STATE OF NEW YORK
COUNTY OF NEW YORK, ss:

John K. Gowen, Jr., being duly sworn, deposes and says:

1. That since May 27, 1946, he has been in the employ of plaintiff, Hazeltine Research, Inc., as licensee representative negotiating license agreements with radio manufacturers and maintaining business contacts with licensees under such agreements;

2. That in August of 1946, the accounting department of plaintiff called to his attention the fact that defendant had failed to make any reports or payments under their Hazeltine Standard License Agreement dated September 1, 1942, since the termination of World War II, and requested him to contact defendant with a view to inducing it to perform its obligations under its license agreement;

3. That on August 14, 1946, he stopped at the general office

of defendant at 122 Brookline Avenue, Boston, Massachusetts, and talked to Jack Housman, Vice-President of defendant, and explained to him defendant's aforesaid delinquency and requested that reports and payments due under aforesaid license agreement be made by defendant, but he was advised by said Jack Housman that such matters were handled by his brother, David Housman, President of defendant, and that the latter was out of the city but Jack Housman promised to take up the matter with said David Housman on his return;

4. That, having failed to receive any further response from any representative of defendant, during the month of November, 1946, he made several long distance telephone calls to defendant, finally making an appointment with aforesaid David Housman for December 3, 1946, and, on that date, accompanied by Laurence B. Dodds, Executive Vice-President of plaintiff, he went from New York to Boston and conferred with aforesaid David Housman in his office. At that conference, defendant's violations of aforesaid license agreement were again explained to said David Housman and a demand was made for royalty reports and payments, but said David Housman then refused to state whether or not his company would fulfill its obligations under aforesaid license agreement without discussing the matter further with its patent counsel, George K. Woodworth, but he agreed to write by December 15, 1946, giving his final decision in the matter; and

5. That on or about January 2, 1947, having had no response from defendant, he telephoned said David Housman by long distance and was advised by said David Housman that defendant refused to, and would not, make royalty reports and payments under aforesaid license agreement.

JOHN K. GOWEN, JR.,

Subscribed and sworn to before me, this first day of October, 1947.

PEGGY COYLE,
Notary Public.

[SEAL]

Commission Expires March 30, 1948

AFFIDAVIT OF JOHN R. BINNS IN SUPPORT OF PLAINTIFF'S MOTION FOR SUMMARY JUDGMENT.

[Filed November 10, 1947.]

STATE OF NEW YORK
COUNTY OF NEW YORK, SS:

John R. Binns, being duly sworn, deposes and says:

1. That he has been an officer of plaintiff and its predecessor, Hazeltine Corporation, since 1924; that he is now and has been since the organization of plaintiff in March, 1946, President of plaintiff and that during such periods he has been familiar with all of the licensing activities of plaintiff and its predecessor, Hazeltine Corporation;

2. That in March, 1946, plaintiff Corporation was organized as a corporation of the State of Illinois and as a wholly-owned subsidiary of Hazeltine Corporation of Washington, D. C., a corporation of Delaware, and that, upon such organization, all of the United States patents and patent applications and all of the license agreements between Hazeltine Corporation and the United States manufacturers of radio and allied equipments were assigned by Hazeltine Corporation to plaintiff for a large and valuable consideration, a copy of such assignment being attached hereto as Exhibit 0;

3. That plaintiff now owns or has the right to grant licenses under some 570 United States patents and some 200 United States patent applications; that these patents and patent applications are largely directed to radio and television transmitters and receivers, including broadcast radio receivers of the type manufactured by defendant, and that these patent rights are now and have been since long prior to 1935, the date of defendant's first license from plaintiff, described hereinafter, generally recognized by the manufacturers of such equipments, plaintiff now having some 130 licensees in this field including such leaders in the industry as General Electric Company, Westinghouse Electric Corporation, Zenith Radio Corporation, Stromberg-Carlson Company, etc.; and that

plaintiff has received large sums in royalties from such licensees each year since long prior to 1935; that Radio Corporation of America, though itself a holder of a large number of patents, as alleged in paragraph 11 of defendant's answer herein, has operated under license from plaintiff and has, during the last ten years, paid plaintiff and its predecessor approximately One Million Dollars ($1,000,000) in royalties and recently renewed its license in the broadcast receiver field for an additional period ending December 31, 1950, and is paying very substantial royalties to plaintiff under a group of patents which is substantially the same patents as those under which defendant is licensed and which include those patents enumerated in plaintiff's answer to defendant's Interrogatory No. 2;

4. That for more than twenty (20) years plaintiff's affiliate company, Hazeltine Electronics Corporation and its predecessor, has operated extensive laboratories engaged in fundamental research, development, engineering design and testing and consulting services for the benefit of the licensees of plaintiff and has spent many millions of dollars in this activity, the budget of Hazeltine Electronics Corporation for the current year for this purpose being Five Hundred Thousand Dollars ($500,000) and that the majority of the aforesaid patents and patent applications owned by plaintiff have resulted from such research and development activities and that such activities are financed solely from royalties received from aforesaid licenses under such inventions;

5. That defendant has persistently violated the rights of plaintiff and its predecessor, Hazeltine Corporation, in the aforesaid inventions and the patents and patent applications based thereon as indicated by the following chronological summary;

(a) On or about October 1, 1935, plaintiff's predecessor, Hazeltine Corporation, entered into a license agreement with defendant for a period ending June 30, 1939, by which Hazeltine Corporation as licensor granted to defendant a non-exclusive license to manufacture and sell certain radio apparatus including broadcast radio receivers at a royalty rate of three per cent. (3%) of the

selling price of the chassis portion of such receivers with usual provisions relative to patent marking, the keeping of records subject to examination by licensor, and the making of reports and royalty payments by licensee to licensor.

(b) From the date of said agreement of October 1, 1935, defendant violated and failed to perform its obligations under said agreement and by letter of March 9, 1936, advised plaintiff's counsel, Medina & Sherpick, of New York, New York, ". . . that it is our present belief that our product does not embody any of the inventions described and claimed in the patents set forth in the license.".

(c) On or about December 18, 1936, plaintiff's predecessor, Hazeltine Corporation, brought an action in equity against defendant in the Massachusetts Superior Court for Suffolk County, Equity No. 47229, seeking to enjoin defendant from manufacturing licensed apparatus without applying proper patent markings and without paying royalties due and without performing its other obligations under such license and seeking also an accounting for royalties past due.

(d) On or about September 24, 1937, there was entered in said action, Equity No. 47229, a consent decree, a certified copy of which is attached hereto and marked Exhibit P, which adjudged that defendant's entire production constituting some twenty-seven (27) models of broadcast radio receivers manufactured and sold by defendant embodied the inventions of a large number of patents owned by Hazeltine Corporation and that each of those patents was valid and infringed by one or more of said twenty-seven models of broadcast radio receivers.

(e) Concurrently with the entry of aforesaid consent decree on September 24, 1937, defendant entered into a settlement agreement with Hazeltine Corporation in the form attached hereto and marked Exhibit Q and the sum of Four Thousand Dollars ($4,000), referred to in such agreement, was paid to Hazeltine Corporation by defendant.

(f) Concurrently with the entry of aforesaid c[illegible] sent decree on

September 24, 1937, defendant also entered into a new license agreement with Hazeltine dated October 1, 1937, for a period of five (5) years and in its then current standard form and which was in substantially the same form as the previous license agreement dated October 1, 1935, except that the 1935 agreement provided for the payment of royalties at stated percentages "on each piece of licensed apparatus sold by Licensee", while the 1937 agreement, for convenience of accounting, provided for royalties based on sales of "each piece of apparatus identified in Article II, Section 2, sold by Licensee", which is identical to the royalty payment obligation contained in Article IV, Section 1, of the current form of license agreement, Exhibit A, and that, with the exception of defendant, all licensees under licenses of the form of said 1937 agreement and of the form of said current license agreement have reported and paid royalties on the basis of all broadcast receivers manufactured and sold by them without raising with plaintiff or its predecessor any question as to whether such receivers embodied any one or more, or none, of the several hundred patents under which the license was granted.

(g) For a certain period, beginning October 1, 1937, the date of the second aforesaid license agreement, and extending until February, 1940, defendant paid royalties to Hazeltine Corporation under said agreement on the basis of its entire production of broadcast receivers but such payments and reports were made belatedly in nearly every instance and only after, and as a result of, insistent and continued demands on defendant; thereafter defendant again became delinquent and failed and refused to pay royalties and to fulfill its other obligations under the said agreement of October 1, 1937, and, on application of plaintiff, on or about December 3, 1941, there was entered in the said action, Equity No. 47229, a final decree, a certified copy of which is attached and marked Exhibit R, which in substance continued the provisions of aforesaid consent decree of September 24, 1937.

(h) On May 12, 1941, the United States Supreme Court held invalid one of plaintiff's important patents, Re. 19,744 Wheeler,

directed to an automatic-volume-control system for radio receivers, reversing decisions of the Sixth Circuit Court of Appeals and the United States District Court, Eastern District of Michigan, which had held that patent valid and infringed; thereupon plaintiff, by letter of May 14, 1941, notified each of its licensees of such decision, copy of such notice to defendant being attached hereto as Exhibit R1, which notice defendant acknowledged by its letter of May 16, 1941, a photostatic copy of which is attached hereto as Exhibit R2; that in view of such decision of the Supreme Court and promptly thereafter plaintiff offered to each of its licensees a new license at rates of royalty thirty per cent. (30%) below those then in effect, such offer to defendant being made by a letter to defendant dated August 25, 1941; that on or about September 18, 1942, pursuant to extended negotiations following the entry of said final decree of December 3, 1941, Hazeltine Corporation entered into a further settlement with defendant as a result of which it granted to defendant, and defendant accepted, the new license carrying the lower royalty rates, which then was the current Hazeltine standard license agreement and is the agreement now in force with defendant, a copy of which is attached to the complaint herein as Exhibit A.

(i). That on or about April 30, 1942, by various executive orders culminating in Limitation Order No. L-265 of the War Production Board, the Government prohibited the manufacture and sale for civilian use of all radio apparatus covered by the agreement, which order was revoked on or about August 30, 1945; that since such revocation of Limitation Order No. L-265 on or about August 30, 1945, defendant has persistently and continuously failed and refused to perform its obligations under said agreement including, among others, the payment of royalties due under Article IV; the keeping of records, the making of reports, and permission to representatives of plaintiff or its predecessor, Hazeltine Corporation, to inspect the same under the provisions of Article V;

6. That in the negotiations of the licenses described above in paragraphs 5(f) and 5(h), in the litigation described above in paragraphs 5(c), 5(d), and 5(g), and in the settlements described

in paragraphs 5(e) and 5(h), defendant was represented by experienced patent counsel, George K. Woodworth, attorney for defendant in the present action; that said George K. Woodworth agreed to and signed the aforesaid consent decree dated September 24, 1937, after plaintiff had filed answers to a large number of Interrogatories propounded by defendant which brought out the particulars of infringement in that case;

7. That there are now due and owing plaintiff from defendant under aforesaid agreement dated September 1, 1942, the minimum annual royalty of Ten Thousand Dollars ($10,000) for the fiscal license year ending August 31, 1946, and, in addition thereto, royalties at rates specified in Article IV, Section 1, of aforesaid agreement on radio receiving apparatus manufactured and sold by defendant since September 1, 1942, the amounts of which are unknown and unascertainable to plaintiff without the accounting prayed for in the complaint herein;

8. None of the 130 licensees of plaintiff, except defendant and one other, have since August 30, 1945, ignored or are now ignoring their obligations under their respective license agreements with plaintiff although there are a few of such licensees which are undergoing financial re-organization under the bankruptcy laws or are involved in like proceedings or are otherwise in financial difficulties and are thus somewhat in arrears in their royalty payments but which have recognized their royalty obligations;

9. That a great majority of the patents and patent applications enumerated in Schedules A and B of aforesaid license agreement of September 1, 1942, resulted from the research and development work of plaintiff's affiliate Hazeltine Electronics Corporation described in paragraph 4 above; that of the Latour Corporation patents enumerated in said Schedule A only three (3) are unexpired and those are not presently in commercial use; that the rights under the patents of the Atwater-Kent Manufacturing Company, Zenith Radio Corporation, and United American Bosch Corporation enumerated in said Schedule A were acquired by plaintiff as an incident to settlements for past infringement at the time those companies respectively were granted and accepted Hazeltine standard license

agreements under which they paid to Hazeltine royalties at the standard rate; that the few patents acquired from others, not named, enumerated in said Schedule A were also acquired largely incidentally in the process of settlement of various Patent Office interferences and similar controversies; it is now and always has been the policy of plaintiff and its predecessor, Hazeltine Corporation, to license any and all responsible manufacturers of radio apparatus and to include such acquired patent rights in its licenses, without any charge in addition to its standard royalty rate which for many years has been approximately one per cent. (1%); and that, in fact, plaintiff has never endeavored to eliminate competition or secure any monopoly and has not eliminated competition or achieved any monopoly or near monopoly in the patents in the radio receiver field since it owns or controls only a small fraction of the patents in this field; that Radio Corporation of America, referred to in paragraph 11 of the answer herein, owns or has the right to grant licenses under several thousand patents in this field and does grant licenses comparable to plaintiff at a basic royalty rate of two and one-quarter per cent. (2-1/4%); and that there are also other patent owners and licensors in this field, such as Major Edwin H. Armstrong, Philco Corporation, Zenith Radio Corporation, Johnson Laboratories, etc., each of which owns a substantial number of patents in this field;

10. That, of the patents referred to in plaintiff's answer to defendant's Interrogatory No. 2, namely,

Re.19,765
Re.20,400
1,913,604
1,951,685
1,958,027
2,015,327
2,021,692
2,022,514
2,041,273
2,041,291

none has been held invalid in any litigation with the exception of patents 1,951,685 and 2,041,273 which are now involved in Civil Actions No. 2426 and No. 2436, respectively, entitled *Hazeltine Research, Inc.* v. *General Motors Corporation,* (U.S.D.C. E.D. Michigan, Southern Division), which actions are now on appeal to the Circuit Court of Appeals for the Sixth Circuit, while two of such patents, Nos. 1,913,604 and 2,022,514, were held not infringed in an action entitled *Hazeltine Corporation* v. *The Crosley Corporation* by the United States Circuit Court of Appeals for the Sixth Circuit, 130 F. (2d) 344.

11. That it is, and always has been, the policy of plaintiff and its predecessor, Hazeltine Corporation, to notify all licensees of any court decisions adversely affecting the scope or validity of any of its patents, as a result of which such decisions immediately become matters of common knowledge in the radio industry.

JOHN R. BINNS.

Sworn to and subscribed before me this twenty-seventh day of October, 1947.

PEGGY COYLE,

[SEAL] *Notary Public.*

Commission Expires March 30, 1948

Exhibit O attached to and forming part of Affidavit of John R. Binns Civil Action 6677

REEL 1206 PAGE 433

PATENT ASSIGNMENT

In consideration of One Dollar ($1.00) and other good and valuable consideration, the receipt of which is hereby acknowledged, HAZELTINE CORPORATION, of Washington, D. C., a corporation organized and existing under the laws of the State of Delaware, (hereinafter called ASSIGNOR) hereby sells and assigns unto HAZELTINE RESEARCH, INC., of Chicago, Illinois, a corporation organized and existing under the laws of the State of Illinois, (hereinafter called ASSIGNEE) its successors, assigns and nominees, the following inventions, patents and patent and contractual rights:

(1) The entire right, title and interest in and to the United States Letters Patent enumerated in Schedule A attached hereto and made a part hereof and all reissues and extensions thereof, together with the right to all claims for past infringement thereof and the right to sue for and recover such claims for the exclusive benefit of ASSIGNEE.

(2) The entire right, title and interest in and to the applications for United States Letters Patent enumerated in Schedule B attached hereto and made a part hereof and all divisions and continuations thereof and all Letters Patent which may be granted therefor and all reissues and extensions thereof. ASSIGNOR agrees to authorize and request the Commissioner of Patents to issue all patents resulting from said applications to ASSIGNEE as assignee of the entire interest.

(3) The inventions disclosed or claimed in the United States Letters Patent and applications therefor enumerated in aforesaid Schedules A and B, but excluding the right to apply for Letters Patent thereon in all countries foreign to the United States and any and all Letters Patent issuing on such foreign applications.

(4) ASSIGNOR'S entire rights and interest in to and under the United States Letters Patent enumerated in Schedule C attached hereto and made a part hereof, pursuant to the respective agreements identified therein.

(5) All rights of ASSIGNOR under certain Employment and Retainer Agreements between HAZELTINE ELECTRONICS CORPORATION, a subsidiary of ASSIGNOR, and employees and inventors, including the respective inventor or inventors named in each of the Letters Patent and applications therefor enumerated in Schedules A and B.

(6) All contractual rights of ASSIGNOR stated in or resulting from assignments or contracts to assign by which ASSIGNOR acquired the Letters Patent enumerated in Schedule A, the applications enumerated in Schedule B and the inventions thereof, insofar as the same relate to the United States.

The foregoing assignments are subject to the following reservations:

(a) The outstanding license rights identified in a certain License Assignment executed by ASSIGNOR and ASSIGNEE concurrently herewith.

(b) Licenses under the patents entitled "Miscellaneous" of Schedule C to the respective parties to the Agreements identified therein.

(c) Certain licenses to the United States Government under the Letters Patent and applications therefor so identified in Schedules A and B.

(d) A license to the United States Government under a certain License Agreement dated as of July 1, 1942, under certain of the Letters Patent and applications therefor of Schedules A, B, and C, such license continuing during a period ending six (6) months after cessation of hostilities between the United States and the countries with which it was at war on July 1, 1942.

(e) The foregoing assignments are also subject to the assumption by ASSIGNEE of all obligations now or hereafter resting upon ASSIGNOR under or by virtue of the assignments or agreements by which ASSIGNOR acquired the Letters Patent and applications therefor and the inventions and rights hereby assigned and such performance thereof by ASSIGNEE that ASSIGNOR shall hereafter be free and clear of all such obligations and liability for the performance thereof.

(f) ASSIGNOR further agrees to execute any and all further documents reasonably necessary to effectuate the transfer to ASSIGNEE of the rights recited herein.

IN WITNESS THEREOF, the parties hereto have caused this instrument to be executed in duplicate by their proper officers thereunto duly authorized.

HAZELTINE CORPORATION

By Jack Binns
President

ATTEST:

Hamlet Page
Assistant Secretary

HAZELTINE RESEARCH, INC.

By Lawrence B. Odds
Executive Vice-President.

ATTEST:

Paul Armstrong
Secretary

State of New York)
) ss.:
County of New York)

On this 28th day of March, 1946; before me personally came JACK BIRNS, to me known, and who being by me duly sworn, did depose and say: that he is the President of Hazeltine Corporation, one of the corporations described in and which executed the above instrument, and that he knows the seal of said corporation, and the seal affixed to said instrument is said corporate seal, and that it was so affixed by authority of the Board of Directors of the said corporation, and that he signed his name thereto by like authority.

Peggy Coyle
Notary Public

PEGGY COYLE
NOTARY PUBLIC Kings County
Kings County Clerk's No. 78
New York Co. Clerk's No. 94
Commission Expires March 30, 1946

State of New York)
) ss.:
County of New York)

On this 28th day of March, 1946, before me personally came Lawrence B. Dodds, to me known, and who being by me duly sworn, did depose and say: that he is the Executive Vice-President of Hazeltine Research, Inc., one of the corporations described in and which executed the above instrument, and that he knows the seal of said corporation, and the seal affixed to said instrument is said corporate seal, and that it was so affixed by authority of the Board of Directors of the said corporation, and that he signed his name thereto by like authority.

Peggy Coyle
Notary Public

PEGGY COYLE
NOTARY PUBLIC Kings County
Kings County Clerk's No. 78
New York Co. Clerk's No. 94
Commission Expires March 30, 1946

SCHEDULE A

United States Letters Patent

Patent No.	Issued	Patent No.	Issued
Re. 17,530	Dec. 17, 1929	1,866,687	July 12, 1932
Re. 19,170	May 15, 1934	1,868,155	July 19, 1932
Re. 19,744	Oct. 29, 1935	1,869,894	Aug. 2, 1932
Re. 19,765	Nov. 26, 1935	1,873,236	Aug. 23, 1932
Re. 19,823	Jan. 14, 1936	1,875,837	Sept. 6, 1932
Re. 20,400	June 8, 1937	1,878,614	Sept. 20, 1932
Re. 20,632	Jan. 18, 1938	1,878,653	Sept. 20, 1932
Re. 21,153	July 18, 1939	1,878,740	Sept. 20, 1932
Re. 21,176	Aug. 15, 1939	1,878,741	Sept. 20, 1932
Re. 21,222	Oct. 3, 1939	1,878,742	Sept. 20, 1932
Re. 21,691	Jan. 14, 1941	1,878,743	Sept. 20, 1932
Re. 21,826	June 17, 1941	1,879,861	Sept. 27, 1932
Re. 21,839	June 24, 1941	1,879,862	Sept. 27, 1932
Re. 22,055	Mar. 24, 1942	1,881,235	Oct. 4, 1932
Re. 22,112	June 9, 1942	1,881,284	Oct. 4, 1932
Re. 22,115	June 16, 1942	1,883,794	Oct. 18, 1932
Re. 22,139	July 21, 1942	1,888,278	Nov. 22, 1932
Re. 22,195	Oct. 6, 1942	1,892,554	Dec. 27, 1932
Re. 22,275	Feb. 23, 1943	1,893,813	Jan. 10, 1933
Re. 22,302	April 20, 1943	1,894,503	Jan. 17, 1933
Re. 22,390	Nov. 9, 1943	1,895,091	Jan. 24, 1933
Re. 22,576	Dec. 12, 1944	1,896,500	Feb. 7, 1933
1,710,035	April 23, 1929	1,904,185	April 18, 1933
1,721,520	July 23, 1929	1,907,916	May 9, 1933
1,733,504	Oct. 29, 1929	1,908,934	May 16, 1933
1,755,114	April 15, 1930	1,910,399	May 23, 1933
1,755,115	April 15, 1930	1,910,827	May 23, 1933
1,757,494	May 6, 1930	1,910,870	May 23, 1933
1,762,431	June 10, 1930	1,913,604	June 13, 1933
1,763,380	June 10, 1930	1,913,693	June 13, 1933
1,763,796	June 17, 1930	1,921,087	Aug. 8, 1933
1,776,592	Sept. 23, 1930	1,921,088	Aug. 8, 1933
1,781,759	Nov. 18, 1930	1,927,672	Sept. 19, 1933
1,798,962	Mar. 31, 1931	1,930,784	Oct. 17, 1933
1,823,327	Sept. 15, 1931	1,931,338	Oct. 17, 1933
1,823,331	Sept. 15, 1931	1,931,596	Oct. 24, 1933
1,829,058	Oct. 27, 1931	1,933,402	Oct. 31, 1933
1,831,431	Nov. 10, 1931	1,934,722	Nov. 14, 1933
1,844,374	Feb. 9, 1932	1,942,587	Jan. 9, 1934
1,845,306	Feb. 16, 1932	1,942,786	Jan. 9, 1934
1,846,701	Feb. 23, 1932	1,943,405	Jan. 16, 1934
1,855,054	April 19, 1932	1,951,685	Mar. 20, 1934
1,855,055	April 19, 1932	1,958,027	May 8, 1934
1,855,619	April 26, 1932	1,960,984	May 29, 1934
1,857,055	May 3, 1932	1,961,154	June 5, 1934

SCHEDULE A

United States Letters Patent

Patent No.	Issued	Patent No.	Issued
1,961,574	June 5, 1934	2,052,184	Aug. 25, 1936
1,968,973	Aug. 7, 1934	2,054,412	Sept. 15, 1936
1,977,745	Oct. 23, 1934	2,054,424	Sept. 15, 1936
1,997,665	April 16, 1935	2,056,390	Oct. 6, 1936
2,000,084	May 7, 1935	2,058,565	Oct. 27, 1936
2,000,113	May 7, 1935	2,061,991	Nov. 24, 1936
2,001,950	May 21, 1935	2,064,774	Dec. 15, 1936
2,007,253	July 9, 1935	2,064,775	Dec. 15, 1936
2,013,121	Sept. 3, 1935	2,072,679	Mar. 2, 1937
2,014,086	Sept. 10, 1935	2,072,708	Mar. 2, 1937
2,015,327	Sept. 24, 1935	2,073,038	Mar. 9, 1937
2,016,760	Oct. 8, 1935	2,073,344	Mar. 9, 1937
2,018,526	Oct. 22, 1935	2,073,345	Mar. 9, 1937
2,018,540	Oct. 22, 1935	2,075,683	Mar. 30, 1937
2,018,545	Oct. 22, 1935	2,077,045	April 13, 1937
2,020,166	Nov. 5, 1935	2,077,049	April 13, 1937
2,021,692	Nov. 19, 1935	2,080,115	May 11, 1937
2,022,067	Nov. 26, 1935	2,080,560	May 18, 1937
2,022,068	Nov. 26, 1935	2,080,646	May 18, 1937
2,022,085	Nov. 26, 1935	2,081,861	May 25, 1937
2,022,514	Nov. 26, 1935	2,084,647	June 22, 1937
2,024,002	Dec. 10, 1935	2,092,709	Sept. 7, 1937
2,024,017	Dec. 10, 1935	2,093,416	Sept. 21, 1937
2,026,075	Dec. 31, 1935	2,099,156	Nov. 16, 1937
2,026,102	Dec. 31, 1935	2,100,402	Nov. 30, 1937
2,028,511	Jan. 21, 1936	2,100,733	Nov. 30, 1937
2,034,013	Mar. 17, 1936	2,103,022	Dec. 21, 1937
2,034,014	Mar. 17, 1936	2,103,079	Dec. 21, 1937
2,036,319	April 7, 1936	2,103,097	Dec. 21, 1937
2,036,343	April 7, 1936	2,105,902	Jan. 18, 1938
2,038,253	April 21, 1936	2,110,664	Mar. 8, 1938
2,038,294	April 21, 1936	2,111,483	Mar. 15, 1938
2,038,358	April 21, 1936	2,115,463	April 26, 1938
2,038,359	April 21, 1936	2,115,676	April 26, 1938
2,039,136	April 28, 1936	2,118,352	May 24, 1938
2,041,273	May 19, 1936	2,118,977	May 31, 1938
2,041,291	May 19, 1936	2,129,727	Sept. 13, 1938
2,042,571	June 2, 1936	2,129,740	Sept. 13, 1938
2,045,569	June 30, 1936	2,137,123	Nov. 15, 1938
2,045,910	June 30, 1936	2,137,266	Nov. 22, 1938
2,048,527	July 21, 1936	2,137,318	Nov. 22, 1938
2,048,528	July 21, 1936	2,147,509	Feb. 14, 1939
2,049,147	July 28, 1936	2,148,604	Feb. 28, 1939
2,050,679	Aug. 11, 1936	2,148,633	Feb. 28, 1939
2,050,680	Aug. 11, 1936	2,150,044	Mar. 7, 1939
2,052,183	Aug. 25, 1936	2,151,107	Mar. 21, 1939

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United States Letters Patent

Patent No.	*Issued*	*Patent No.*	*Issued*
2,152,470	Mar. 28, 1939	2,188,658	Jan. 30, 1940
2,152,481	Mar. 28, 1939	2,188,970	Feb. 6, 1940
2,152,482	Mar. 28, 1939	2,189,287	Feb. 6, 1940
2,152,514	Mar. 28, 1939	2,189,310	Feb. 6, 1940
2,152,515	Mar. 28, 1939	2,189,848	Feb. 13, 1940
2,152,618	Mar. 28, 1939	2,189,849	Feb. 13, 1940
2,153,857	April 11, 1939	2,190,816	Feb. 20, 1940
2,154,141	April 11, 1939	2,191,796	Feb. 27, 1940
2,154,907	April 18, 1939	2,192,971	Mar. 12, 1940
2,156,137	April 25, 1939	2,192,991	Mar. 12, 1940
2,159,240	May 23, 1939	2,194,292	Mar. 19, 1940
2,163,234	June 20, 1939	2,195,438	April 2, 1940
2,165,468	July 11, 1939	2,196,881	April 9, 1940
2,167,134	July 25, 1939	2,197,239	April 16, 1940
2,167,135	July 25, 1939	2,198,969	April 30, 1940
2,167,136	July 25, 1939	2,198,983	April 30, 1940
2,167,137	July 25, 1939	2,201,365	May 21, 1940
2,167,400	July 25, 1939	2,201,770	May 21, 1940
2,167,405	July 25, 1939	2,203,519	June 4, 1940
2,168,193	Aug. 1, 1939	2,203,520	June 4, 1940
2,168,461	Aug. 8, 1939	2,203,521	June 4, 1940
2,168,874	Aug. 8, 1939	2,203,528	June 4, 1940
2,169,830	Aug. 15, 1939	2,204,216	June 11, 1940
2,169,831	Aug. 15, 1939	2,204,712	June 18, 1940
2,169,837	Aug. 15, 1939	2,205,190	June 18, 1940
2,169,840	Aug. 15, 1939	2,205,738	June 25, 1940
2,172,750	Sept. 12, 1939	2,206,954	July 9, 1940
2,172,858	Sept. 12, 1939	2,206,989	July 9, 1940
2,172,859	Sept. 12, 1939	2,206,990	July 9, 1940
2,173,173	Sept. 19, 1939	2,208,374	July 16, 1940
2,174,234	Sept. 26, 1939	2,208,382	July 16, 1940
2,174,235	Sept. 26, 1939	2,209,394	July 30, 1940
2,174,566	Oct. 3, 1939	2,210,089	Aug. 6, 1940
2,174,580	Oct. 3, 1939	2,211,352	Aug. 13, 1940
2,177,162	Oct. 24, 1939	2,211,458	Aug. 13, 1940
2,177,688	Oct. 31, 1939	2,211,718	Aug. 13, 1940
2,177,713	Oct. 31, 1939	2,212,172	Aug. 20, 1940
2,177,761	Oct. 31, 1939	2,212,420	Aug. 20, 1940
2,181,499	Nov. 28, 1939	2,214,846	Sept. 17, 1940
2,182,329	Dec. 5, 1939	2,214,847	Sept. 17, 1940
2,183,966	Dec. 19, 1939	2,216,160	Oct. 1, 1940
2,183,980	Dec. 19, 1939	2,216,874	Oct. 8, 1940
2,185,388	Jan. 2, 1940	2,216,997	Oct. 8, 1940
2,185,389	Jan. 2, 1940	2,216,998	Oct. 8, 1940
2,187,978	Jan. 23, 1940	2,217,948	Oct. 15, 1940
2,188,498	Jan. 30, 1940	2,217,957	Oct. 15, 1940

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SCHEDULE A

United States Letters Patent

Patent No.	Issued	Patent No.	Issued
2,218,980	Oct. 22, 1940	2,253,355	Aug. 19, 1941
2,221,015	Nov. 12, 1940	2,254,114	Aug. 26, 1941
2,221,452	Nov. 12, 1940	2,254,435	Sept. 2, 1941
2,221,665	Nov. 12, 1940	2,254,721	Sept. 2, 1941
2,221,666	Nov. 12, 1940	2,255,050	Sept. 9, 1941
2,222,387	Nov. 19, 1940	2,255,403	Sept. 9, 1941
2,226,648	Dec. 31, 1940	2,255,645	Sept. 9, 1941
2,226,706	Dec. 31, 1940	2,255,690	Sept. 9, 1941
2,228,725	Jan. 14, 1941	2,255,691	Sept. 9, 1941
2,230,284	Feb. 4, 1941	2,255,692	Sept. 9, 1941
2,231,704	Feb. 11, 1941	2,255,839	Sept. 16, 1941
2,231,829	Feb. 11, 1941	2,257,092	Sept. 30, 1941
2,233,470	Mar. 4, 1941	2,258,370	Oct. 7, 1941
2,235,131	Mar. 18, 1941	2,259,520	Oct. 21, 1941
2,235,816	Mar. 25, 1941	2,259,349	Oct. 21, 1941
2,235,817	Mar. 25, 1941	2,261,762	Nov. 4, 1941
2,235,859	Mar. 25, 1941	2,261,800	Nov. 4, 1941
2,236,364	Mar. 25, 1941	2,262,707	Nov. 11, 1941
2,239,136	April 22, 1941	2,263,067	Nov. 25, 1941
2,239,776	April 29, 1941	2,263,085	Nov. 25, 1941
2,240,490	May 6, 1941	2,264,018	Nov. 25, 1941
2,240,507	May 6, 1941	2,264,781	Dec. 2, 1941
2,240,533	May 6, 1941	2,264,782	Dec. 2, 1941
2,240,534	May 6, 1941	2,265,826	Dec. 9, 1941
2,240,593	May 6, 1941	2,265,848	Dec. 9, 1941
2,240,700	May 6, 1941	2,269,524	Jan. 13, 1942
2,242,934	May 20, 1941	2,269,540	Jan. 13, 1942
2,242,952	May 20, 1941	2,269,570	Jan. 13, 1942
2,243,599	May 27, 1941	2,269,590	Jan. 13, 1942
2,245,710	June 17, 1941	2,269,539	Jan. 20, 1942
2,246,172	June 17, 1941	2,271,181	Jan. 27, 1942
2,247,511	July 1, 1941	2,271,203	Jan. 27, 1942
2,247,512	July 1, 1941	2,271,964	Feb. 3, 1942
2,247,538	July 1, 1941	2,273,163	Feb. 17, 1942
2,247,898	July 1, 1941	2,273,709	Feb. 17, 1942
2,249,532	July 15, 1941	2,276,488	Mar. 17, 1942
2,249,533	July 15, 1941	2,277,192	Mar. 24, 1942
2,250,170	July 22, 1941	2,277,850	Mar. 31, 1942
2,250,962	July 29, 1941	2,278,159	Mar. 31, 1942
2,251,307	Aug. 5, 1941	2,279,543	April 14, 1942
2,251,929	Aug. 12, 1941	2,280,139	April 21, 1942
2,251,966	Aug. 12, 1941	2,280,181	April 21, 1942
2,252,148	Aug. 12, 1941	2,280,187	April 21, 1942
2,253,312	Aug. 19, 1941	2,280,191	April 21, 1942
2,253,313	Aug. 19, 1941	2,282,106	May 12, 1942
2,253,338	Aug. 19, 1941	2,284,131	May 26, 1942
		2,284,219	May 26, 1942

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United States Letters Patent

Patent No.	Issued	Patent No.	Issued
2,285,038	June 2, 1942	2,305,842	Dec. 22, 1942
2,285,957	June 9, 1942	2,308,375	Jan. 12, 1943
2,288,486	June 30, 1942	2,309,852	Feb. 2, 1943
2,289,948	July 14, 1942	* 2,312,687	Mar. 2, 1943
2,290,517	July 21, 1942	2,313,952	Mar. 16, 1943
2,290,748	July 21, 1942	* 2,316,317	April 13, 1943
2,291,277	July 28, 1942	* 2,321,478	June 8, 1943
2,291,450	July 28, 1942	2,322,528	June 22, 1943
2,292,765	Aug. 11, 1942	* 2,324,548	July 20, 1943
2,293,233	Aug. 18, 1942	2,324,776	July 20, 1943
2,294,182	Aug. 25, 1942	2,327,248	Aug. 17, 1943
2,294,328	Aug. 25, 1942	2,335,983	Dec. 7, 1943
2,294,820	Sept. 1, 1942	2,336,555	Dec. 14, 1943
2,295,443	Sept. 8, 1942	2,343,263	Mar. 7, 1944
2,295,816	Sept. 15, 1942	2,343,561	Mar. 7, 1944
2,300,082	Oct. 27, 1942	2,343,745	Mar. 7, 1944
2,300,451	Nov. 3, 1942	2,343,825	Mar. 7, 1944
2,300,452	Nov. 3, 1942	2,347,064	April 18, 1944
2,300,942	Nov. 3, 1942	2,347,529	April 25, 1944
2,302,124	Nov. 17, 1942	2,384,717	Sept. 11, 1945
2,302,619	Nov. 17, 1942	2,388,001	Oct. 30, 1945
2,302,876	Nov. 24, 1942	2,395,615	Feb. 26, 1946
2,303,184	Nov. 24, 1942	* 2,396,831	Mar. 19, 1946
2,303,987	Dec. 1, 1942	* 2,396,832	Mar. 19, 1946
2,304,091	Dec. 8, 1942		

Note: * Non-exclusive licenses to the Government under these patents terminate on their respective dates.

SCHEDULE B

United States Patent Applications

Application Serial No.	Application Serial No.	Application Serial No.	Application Serial No.
282,146	*503,072	*554,197	*597,777
323,290	*503,073	*554,231	599,002
356,547	503,766	554,232	*599,372
*358,981	507,284	*554,233	*599,985
372,988	507,859	554,238	*599,986
391,480	507,880	*557,953	*599,987
395,172	507,881	*558,531	*600,356
*399,637	508,447	*558,532	*600,864
*401,080	*509,718	*561,613	600,868
407,732	*514,071	563,713	608,038
*411,624	*514,072	*563,714	608,664
414,050	*516,394	563,715	608,686
416,986	*516,914	563,716	608,743
*418,541	*520,016	*565,828	609,790
418,712	520,615	565,947	*614,542
420,772	520,617	*571,610	615,891
*423,514	*521,637	573,436	*615,892
*423,515	*521,926	*579,909	*615,893
432,430	*521,931	*579,954	*615,894
*432,669	*521,932	*579,955	*617,020
433,173	*523,085	*579,975	*619,755
*433,219	524,065	580,375	*621,479
*435,441	*524,078	*581,655	*623,939
*441,024	*525,431	*582,283	625,159
*443,117	*525,523	*582,284	625,171
444,193	527,406	*582,285	*625,895
*444,732	*527,753	*582,662	*626,357
449,393	*531,029	*585,662	*627,473
*460,645	*531,759	*586,348	*627,732
*470,785	*538,518	586,869	631,953
*470,786	540,389	*589,432	632,534
*474,257	*541,747	591,906	632,535
*487,007	542,374	591,907	*633,206
*499,769	542,375	592,639	634,011
*499,770	*547,389	593,217	*639,086
*502,511	*547,636	594,691	643,287
*503,045	549,604	595,291	643,288
*503,069	549,615	597,029	*646,357
*503,070	549,616	*597,035	*649,344
*503,071	549,743	*597,036	*649,345
	549,843	*597,037	*649,346
	*551,733	*597,655	

Note: * Non-exclusive licenses to the Government under these applications terminate on their respective filing dates.

SCHEDULE C

United States Letters Patent
of Latour Corporation

(Rights Acquired Pursuant to
Agreement dated March 31, 1925)

Patent No.	Issued	Patent No.	Issued
1,710,170	April 23, 1929	1,801,774	April 21, 1931
1,791,965	Feb. 10, 1931	1,834,408	Dec. 1, 1931

United States Letters Patent
of Arthur Atwater Kent

(Rights Acquired Pursuant to
Agreement dated March 27, 1924)

Patent No.	Issued	Patent No.	Issued
1,710,482	April 23, 1929	1,757,719	May 6, 1930
1,713,134	May 14, 1929	1,775,399	Sept. 9, 1930
1,719,014	July 2, 1929	1,783,292	Dec. 2, 1930
1,719,057	July 2, 1929	1,794,855	Mar. 3, 1931
1,719,956	July 2, [illegible]	1,796,375	Mar. 17, 1931
1,727,604	Sept. 10, 1929	1,829,007	Oct. 27, 1931
1,730,910	Oct. 1, [illegible]	1,878,514	Oct. 30, 1931
1,743,145	Jan. 14, 1930		

United States Letters Patent
of [illegible] Radio Corporation

(Rights Acquired Pursuant to
Agreement dated January 15, 1934)

Patent No.	Issued	Patent No.	Issued
Re. 17,931	Dec. 17, 1929	1,829,529	Oct. 20, 1931
1,772,077	Aug. 5, 1930	1,836,461	Dec. 15, 1931
1,906,796	May 2, 1933	1,906,106	Apr. 25, 1933
1,774,619	Sept. 2, 1930		

SCHEDULE C

United States Letters Patent of United American Bosch Corporation

(Rights Acquired Pursuant to Agreement dated January 2, 1935)

Patent No.	Issued	Patent No.	Issued
1,770,131	July 8, 1930	1,898,835	Feb. 21, 1933
1,773,573	Aug. 19, 1930	1,908,119	May 9, 1933
1,792,822	Feb. 17, 1931	1,913,586	June 13, 1933
1,818,693	Aug. 11, 1931	1,920,743	Aug. 1, 1933
1,856,774	May 3, 1932	1,944,687	Jan. 23, 1934
1,877,228	Sept. 13, 1932	1,960,479	May 29, 1934
1,891,369	Dec. 20, 1932		

Miscellaneous United States Letters Patent and Application

(Rights Acquired Pursuant to Agreements dated as indicated)

Patent No.	Issued	Agreement Dated
1,890,426	Dec. 6, 1932	Jan. 31, 1941
1,93[illegible],940	[illegible]. 1[illegible], 193[illegible]	Jan. 31, 1941
2,0[illegible],8[illegible]4	Dec. 8, 193[illegible]	July 19, 1935
2,089,270	[illegible]. 10, 1937	Mar. 2, 1936
2,089,271	Aug. 10, 1937	Mar. 2, 1936
2,146,068	Feb. 7, 193[illegible]	Mar. 28, 1938
2,212,968	Aug. 27, 1940	Dec. 10, 1940
2,269,678	Jan. 13, 1942	Apr. 11, 1944
2,333,809	Nov. 9, 1943	Apr. 11, 1944
2,373,601	Apr. 10, 194[illegible]	Jan. 18, 1943

Application Serial No.	Agreement Dated
525,3[illegible]	Apr. 20, 1944

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SCHEDULE 2

United States Letters Patent
of Atwater Kent Manufacturing Company

(Rights Acquired Pursuant to
Agreement dated May 2, 1941)

Patent No.	Issued	Patent No.	Issued
1,726,100	Aug. 27, 1929	1,867,037	July 12, 1932
1,738,575	Dec. 10, 1929	1,872,487	Aug. 16, 1932
1,741,691	Dec. 31, 1929	1,885,304	Nov. 1, 1932
1,749,423	Mar. 4, 1930	1,885,307	Nov. 1, 1932
1,751,854	Mar. 25, 1930	1,886,571	Nov. 8, 1932
1,755,310	April 22, 1930	1,887,329	Nov. 8, 1932
1,760,506	May 27, 1930	1,888,430	Nov. 22, 1932
1,767,837	June 24, 1930	1,889,018	Nov. 29, 1932
1,771,127	July 22, 1930	1,895,809	Jan. 31, 1933
1,771,381	July 22, 1930	1,896,825	Feb. 7, 1933
1,777,500	Oct. 7, 1930	1,906,452	May 2, 1933
1,779,777	Oct. 28, 1930	1,908,381	May 9, 1933
1,787,732	Jan. 6, 1931	1,909,239	May 16, 1933
1,787,950	Jan. 6, 1931	1,915,926	June 27, 1933
1,790,165	Jan. 27, 1931	1,916,129	June 27, 1933
1,791,123	Feb. 3, 1931	1,925,828	Sept. 5, 1933
1,795,090	Mar. 3, 1931	1,926,173	Sept. 12, 1933
1,796,975	Mar. 17, 1931	1,960,599	May 29, 1934
1,810,355	June 16, 1931	1,966,805	July 17, 1934
1,812,349	June 30, 1931	1,971,497	Aug. 28, 1934
1,814,270	July 14, 1931	1,972,279	Sept. 4, 1934
1,814,774	July 14, 1931	1,973,293	Sept. 11, 1934
1,819,299	Aug. 18, 1931	1,983,047	Dec. 4, 1934
1,828,688	Oct. 20, 1931	1,986,641	Jan. 1, 1935
1,829,015	Oct. 27, 1931	1,991,221	Feb. 12, 1935
1,833,085	Nov. 24, 1931	2,001,076	May 14, 1935
1,835,801	Dec. 8, 1931	2,021,321	Nov. 19, 1935
1,836,076	Dec. 15, 1931	2,036,709	April 7, 1936
1,846,616	Feb. 23, 1932	2,257,272	Sept. 30, 1941
1,849,499	Mar. 15, 1932		
1,850,105	Mar. 22, 1932		
1,859,518	May 24, 1932		

RECORDED
U.S. PATENT OFFICE
MAR 30 1946
COMMISSIONER OF PATENTS

LIBER L206 PAGE 433

Exhibit P attached to and forming part of Affidavit of John R. Binns Civil Action 6677

COMMONWEALTH OF MASSACHUSETTS.

Suffolk, ss. Superior Court.
In Equity.
No. 47229

HAZELTINE CORPORATION

vs.

AUTOMATIC RADIO MANUFACTURING COMPANY

DECREE

This cause came on to be further heard at this sitting of the Court and all parties being represented by counsel and consenting to the making and entering of this decree and after hearing thereon, thereupon, upon consideration thereof, it is hereby ordered, adjudged and decreed:—

1. That the defendant has executed and entered into the license agreement which is made a part of the bill of complaint.

2. That pursuant to said agreement and since October 1st, 1935 the defendant has manufactured and sold and is continuing to manufacture and sell apparatus including radio broadcast receivers of sound, as defined in said agreement, all of which embody and employ the inventions of one or more patents owned and controlled by the plaintiff, as enumerated in said license agreement.

3. That the apparatus manufactured and sold by the defendant since October 1st, 1935 and which the defendant is continuing to manufacture and sell pursuant to said agreement includes complete radio broadcast receivers of sound, as defined in said agreement, which receivers have been identified by the type or model designations set forth below and in which are employed and embodied the inventions and improvements of the patents, the numbers of which are set forth opposite said respective type or model designations:

Auto Models described by Diagrams A, B and C respectively attached to plaintiff's interrogatories, 5 Tube Super Midget, 4 (and 5) Tube T. R. F. Midget, Models S-6, C-4, C-41, D-5, D-50, D-50A, J-50, J-60, A-5, J-80, B-30 Series I, B-30 Series II, B-40, B-50, B-70, B-80, M-10, M-20, M-60, M-80, R-6, R-61.	Re 16,461 1382738 1405523 1572,504 1710035 1755114 1755115
Auto Models described by Diagrams A, B, and C respectively attached to plaintiff's interrogatories, 5 Tube Super Midget, Models J-50, J-60, A-5, J-80, B-30 Series I, B-30 Series II, B-40, B-50, B-70, B-80, M-10, M-20, M-60, M-80, R-6, R-61.	Re 19,744 1951,685 2041,273
Auto Models described by Diagrams B and C respectively attached to plaintiff's interrogatories, 5 Tube Super Midget, 4 (and 5) Tube T. R. F. Midget Models S-6, C-4, C-41, D-5, D-50, D-50A, J-50, J-60, A-5, J-80, B-30 Series I, B-30 Series II, B-40, B-50, B-70, B-80, M-80, R-6, R-61.	1913604 2022514
Auto Models described by Diagrams B and C attached to plaintiff's interrogatories, 5 Tube Super Midget, Models S-6, J-50, J-60, A-5, J-80, B-30 Series I, B-30 Series II, B-40, B-50, B-70, B-80, M-10, M-20, M-60, M-80, R-6, R-61.	1958027 2015327 2041291
Auto Models, described by Diagrams A, B, and C attached to plaintiff's interrogatories, 5 Tube Super Midget, 4 (and 5) Tube T. R. F. Midget, Models S-6, D-5, D-50, D-50A, J-50, J-60, A-5, J-80, B-30 Series I, B-30 Series II, B-40, B-50, B-70, B-80, M-10, M-20, M-60, M-80, R-6, R-61.	1991221
4 (and 5) Tube T. R. F. Midget	Re 19,823

Auto Models described by Diagrams A, B and C attached to plaintiff's interrogatories, Models S-6, J-50, J-60, A-5, M-10, M-20, M-60.	1614136
5 Tube Super Midget, 4 (and 5) Tube T. R. F. Midget, Models S-6, C-4, C-41, D-5, D-50, D-50A, M-60.	1763,380
4 (and 5) Tube T. R. F. Midget, Models C-4, C-41, D-5, D-50, D-50A, M-80.	1798,962
4 (and 5) Tube T. R. F. Midget, Models D-5, D-50, D-50A.	1833085
Models S-6, C-4, C-41, B-40, B-50, R-6, R-61.	1857055
Auto Models described by Diagram C attached to plaintiff's interrogatories, 5 Tube Super Midget, 4 (and 5) Tube T. R. F. Midget, Models S-6, C-4, C-41, D-5, D-50, D-50A, J-50, J-60, A-5, J-80.	1892354
Auto Models described by Diagrams B and C attached to plaintiff's interrogatories, 5 Tube Super Midget, Models S-6, J-50, J-60, A-5, J-80, D-30 Series I, D-30 Series II, B-40, B-50, B-70, B-80, M-10, M-20, M-60, M-80, R-6, R-61.	1878614
5 Tube Super Midget, 4 (and 5) Tube T. R. F. Midget, Models S-6, C-4, C-41, D-5, D-50, D-50A.	1920743
5 Tube Super Midget, 4 (and 5) Tube T. R. F. Midget, Models S-6, C-4, C-41, D-5, D-50, D-50A, B-30 Series I, B-30 Series II, B-40, B-50, B-70, B-80, R-6, R-61.	1927672
Models J-50, J-60, A-5, B-50, B-70, B-80.	2080646

and other radio broadcast receivers of sound employing apparatus, circuits and circuit arrangements substantially similar to those employed in the above-identified types and models, or any of them.

4. That the defendant has admitted and does admit for the respective terms thereof the validity of all the patents owned or controlled by the plaintiff and that the claims or several of them of patents Nos.:

Re.16,461	1,878,614
Re.19,744	1,892,354
Re.19,823	1,913,604
1,382,738	1,920,743
1,405,523	1,927,672
1,572,504	1,951,685
1,614,136	1,958,027
1,710,035	1,991,221
1,755,114	2,015,327
1,755,115	2,022,514
1,763,380	2,041,273
1,798,962	2,041,291
1,833,085	2,080,646
1,857,055	

cover all the radio broadcast receivers of sound which the defendant has manufactured and sold since October 1st, 1935 and which the defendant is now manufacturing and selling.

5. That the defendant has not paid the plaintiff any royalties under the aforesaid agreement and is indebted to the plaintiff therefor and the plaintiff is entitled to recover herein said royalties on all the radio broadcast receivers of sound manufactured and sold by the defendant from October 1st, 1935 to the present.

6. That the plaintiff shall be entitled to an accounting to determine said indebtedness, and for said purpose is to have access to all contracts, books of account, sales records and any and all memoranda which may serve to establish the debt, and the defendant, its officers, agents, attorneys and servants, are hereby en-

joined from disposing in any manner of any of said contracts, books of account; sales records and memoranda which may serve to establish the debt until the accounting has been had, the debt established, and execution has been issued thereon in common form.

7. That no order for an accounting is made herein, but such order may be had upon application by the plaintiff.

8. That the defendant be and is hereby enjoined from selling or in any manner disposing of any radio broadcast receivers of sound which by this court is determined to embody and employ the inventions or patents owned and controlled by the plaintiff without properly marking same, as required by said license agreement.

9. That unless an accounting is ordered herein prior to April 1, 1939 or some other matter herein is pending before the Court on April 1, 1939, then the plaintiff shall be awarded one dollar ($1.00) damages and costs and this decree shall become final.

By the Court, (Williams, J.)

D. PULSIFER COLVILLE
Asst. Clerk.

Sept. 24, 1937

Assented to:

Hazeltine Corporation, Plaintiff
By
Vice-President and Treasurer

Goldkrand & Goldkrand
Plaintiff's Attorneys

Automatic Radio Manufacturing Company, Defendant
By
President

Geo. K. Woodworth
Meyer F. Englander
Defendant's Attorneys

Copy,

Attest:

JOSEPH R. CLEARY,
Ass't Clerk.

[SEAL]

No. 47229 Eq.

HAZELTINE CORPORATION

vs.

AUTOMATIC RADIO MFG. CO.

DECREE

Williams, J.

Sept. 24, 1937

Copy,

Attest:

Clerk.

From the office of
Goldkrand & Goldkrand
73 Tremont Street
Boston, Massachusetts

Exhibit Q attached to and forming part of Affidavit of John R. Binns Civil Action 6677

A G R E E M E N T

Agreement made this seventeenth day of September, 1937 by and between Hazeltine Corporation, a corporation organized and existing under the laws of the State of Delaware, hereinafter called HAZELTINE and Automatic Radio Manufacturing Company, a corporation organized and existing under the laws of the State of Massachusetts, hereinafter called AUTOMATIC.

WHEREAS the parties hereto have of even date agreed to the making and entering of a decree in the suit now pending between said parties in the Superior Court for the County of Suffolk, Commonwealth of Massachusetts, entitled Hazeltine Corporation vs. Automatic Radio Manufacturing Company and numbered 47229 Equity on the docket of said court, involving a license agreement between said parties which is incorporated in the bill of complaint in said suit and is dated October 1, 1935 and is hereinafter referred to by said date, and

WHEREAS AUTOMATIC is desirous of entering into a new license agreement with HAZELTINE,

NOW THEREFORE, in consideration of the premises and other good and valuable consideration paid, receipt whereof is hereby acknowledged, it is agreed as follows:

1. AUTOMATIC agrees to pay HAZELTINE on or before October 1, 1937 ONE THOUSAND ($1,000.00) DOLLARS in cash and to deliver to HAZELTINE six (6) promissory notes duly executed by it each in the amount of FIVE HUNDRED ($500.00) DOLLARS payable on November 1, 1937, December 1, 1937, January 1, 1938, February 1, March 1, 1938, 1938 and April 1, 1938 respectively. Further, AUTOMATIC agrees to obtain the endorsements on each of said notes of David Housman and Abraham J. Housman, which endorsers shall waive notice of demand, protest, notice of dishonor and of non-payment.

2. Hazeltine upon receipt of said one thousand dollars ($1000)and of said six (6) promissory notes agrees to execute and deliver to AUTOMATIC a new license agreement effective as of October 1,1937, two copies of which have this day been executed by AUTOMATIC.

3. Upon the delivery by Hazeltine to Automatic of said new license agreement, the said license agreement of October 1st,1935 will be terminated as of October 1,1937, but the termination of said license agreement of October 1,1935 will not in any manner or way be a release to AUTOMATIC from any of the liabilities of said license of October 1st, 1935 accruing to HAZELTINE prior to October 1st, 1937.

4. HAZELTINE agrees that it will not apply to the aforesaid Court for an accounting of any royalties due it under the aforesaid license agreement of October 1,1935 so long as AUTOMATIC renders the reports, pays the royalties, and performs all its obligations and duties under said new license agreement, and pays the said promissory notes as they mature.

5. That upon any default by AUTOMATIC in the payment of royalties, rendering of reports, or any of its other obligations or duties under the aforesaid new license agreement, excepting those created by Article III, Section 4 thereof, HAZELTINE may upon THIRTY (30) days notice given by registered letter, of its intention to do so at any time prior to April 1, 1939, but not after said date, apply to the aforesaid Court to determine the existence of such default, and should such determination be adverse to AUTOMATIC and the default not rectified within three (3) days thereafter, HAZELTINE may then apply to the aforesaid court fo the accounting provided in the consent decree in the above entitled case. Provided, However, that if such default consists in the failure to pay said promissory notes or any of them, HAZELTINE may apply to the aforesaid Court to order said accounting without a judicial determination that such default exists. Provided further that, if the amount found by such accounting to be due and owing to HAZELTINE exceeds the sum paid by AUTOMATIC under paragraph 1 hereof the amount so paid by AUTOMATIC shall be credited against the sum so found to be due and owing to HAZELTINE.

IN WITNESS WHEREOF, the parties hereto have caused this instrument to be executed in duplicate by their proper officers thereunto duly authorized.

AUTOMATIC RADIO MANUFACTURING COMPANY

By David Houseman
Pres. & Treas

Asst Secretary

HAZELTINE CORPORATION

By W. A. MacDonald
Vice Pres

Asst Secretary

State of Mass)
County of Suffolk) ss.:

On this 18th day of Sept, 1937, before me personally came David Houseman, to me known, and who being by me duly sworn, did depose and say; that he is the President of Automatic Radio Manufacturing Company, one of the corporations described in and which executed the above instrument, and that he knows the seal of said corporation, and the seal affixed to said instrument is said corporate seal, and that it was so affixed by order of the Board of Directors of the said corporation, and that he signed his name thereto by like order.

Meyer F. Englander
Notary Public.

State of N.Y.)
County of N.Y.) ss.:

On this 21st day of September, 1937, before me personally came W. A. MacDonald, to me known, and who being by me duly sworn, did depose and say; that he is the Vice President of Hazeltine Corporation, one of the corporations described in and which executed the above instrument, and that he knows the seal of said corporation, and the seal affixed to said instrument is said corporate seal, and that it was so affixed by order of the Board of Directors of the said corporation, and that he signed his name thereto by like order.

D. L. Reinschmidt
Notary Public.

Exhibit R attached to and forming part of Affidavit of John R. Binns Civil Action 6677

COMMONWEALTH OF MASSACHUSETTS

Suffolk: ss.

Superior Court
In Equity
No. 47229

HAZELTINE CORPORATION

vs

AUTOMATIC RADIO MANUFACTURING COMPANY

FINAL DECREE

This cause came on to be further heard at this sitting of the Court and all parties being represented by counsel, and after hearing thereon, thereupon, upon consideration thereof, it is hereby Ordered, Adjudged and Decreed:—

That the defendant has entered into and executed the license agreement which is a part of the Bill of Complaint;

That pursuant to said license agreement and since October 1, 1935, the defendant has manufactured and sold and is continuing to manufacture and sell apparatus including radio broadcast receivers of sound, as defined in said license agreement, all of which embody and employ the inventions of one or more patents owned and controlled by the plaintiff and enumerated in said license agreement;

That said apparatus manufactured and sold by the defendant since October 1, 1935, and which the defendant is continuing to manufacture and sell pursuant to said agreement, includes complete radio broadcast receivers of sound, as defined in said agreement, and are identified by the type or model designations hereinafter set forth and in which are employed and embodied the inventions and improvements of the patents, the numbers of which are set forth opposite said respective type or model designations, to wit:—

Auto Models described by Diagrams A, B, and C respectively attached to plaintiff's interrogatories, 5 Tube Super Midget, 4 (and 5) Tube T. R. F. Midget, Models S-6, C-4, C-41, D-5, D-50, D-50A, J-50, J-60, A-5, J-80, B-30 Series I, B-30 Series II, B-40, B-50, B-70, B-80, M-10, M-20, M-60, M-80, R-6, R-61.	)	Re 16,461 1382738 1405523 1572,504 1710035 1755114 1755115
Auto Models described by Diagram A, B, and C respectively attached to plaintiff's interrogatories, 5 Tube Super Midget, Models J-50, J-60 A-5, J-80, B-30 Series I, B-30 Series II, B-40 B-50, B-70, B-80, M-10, M-20, M-60, M-80, R-6, R-61.	)	Re 19,744 1951,685 2041,273
Auto Models described by Diagrams B and C respectively, attached to plaintiff's interrogatories, 5 Tube Super Midget, 4 (and 5) Tube T. R. F. Midget Models, S-6, C-4, C-41, D-5, D-50, D-50A, J-50, J-60, A-5, J-80, B-30 Series I, B-30 Series II, B-40, B-50, B-70, B-80, M-80, R-6, R-61.	)	1913604 2022514
Auto Models described by Diagrams B and C attached to plaintiff's interrogatories, 5 Tube Super Midget, Models S-6, J-50, J-60, A-5, J-80, B-30 Series I, B-30 Series II, B-40, B-50, B-70, B-80 M-10, M-20, M-60, M-80, R-6, R-61.	)	1958027 2015327 2041291
Auto Models, described by Diagrams A, B, and C attached to plaintiff's interrogatories, 5 Tube Super Midget, 4 (and 5) Tube T. R. F. Midget, Models S-6, D-5, D-50, D-50A, J-50, J-60, A-5, J-80, B-30 Series I, B-30 Series II, B-40, B-50, B-70, B-80, M-10, M-20, M-60, M-80, R-6, R-61.	)	1991221

4 (and 5) Tube T. R. F. Midget	Re 19,823
Auto Models described by Diagrams A, B and C attached to plaintiff's interrogatories, Models S-6, J-50, J-60, A-5, M-10, M-20, M-60.	1614136
5 Tube Super Midget, 4 (and 5) Tube T. R. F. Midget, Models S-6, C-4, C-41, D-5, D-50, D-50A, M-60	1763,380
4 (and 5) Tube T. R. F. Midget, Models C-4, C-41 D-5, D-50, D-50A, M-80.	1798,962
4 (and 5) Tube T. R. F. Midget, Models D-5, D-50, D-50A.	1833085
Models S-6, C-4, C-41, B-40, B-50, R-6, R-61.	1857055
Auto Model described by Diagram C attached to Plaintiff's interrogatories, 5 Tube Super Midget, 4 (and 5) Tube T. R. F. Midget, Models S-6, C-4, C-41, D-5, D-50, D-50A, J-50, J-60, A-5, J-80.	1892354
Auto Models described by Diagrams B and C attached to plaintiff's interrogatories, 5 Tube Super Midget, Models S-6, J-50, J-60, A-5, J-80, D-30 Series I, D-30 Series II, B-40, B-50, B-70, B-80, M-10, M-20, M-60, M-80, R-6, R-61.	1878614
5 Tube Super Midget, 4 (and 5) Tube T. R. F. Midget, Models S-6, C-4, C-41, D-5, D-50, D-50A.	1920743
5 Tube Super Midget, 4 (and 5) Tube T. R. F. Midget, Models S-6, C-4, C-41, D-5, D-50, D-50A, B-30 Series I, B-30 Series II, B-40, B-50, B-70, B-80, R-6, R-61.	1927672
Models J-50, J-60, A-5, B-50, B-70, B-80.	2080646

and other radio broadcast receivers of sound employing apparatus, circuits and circuit arrangements substantially similar to those employed in the above-identified types and models, or any of them.

That the defendant has admitted and does admit for the respective terms thereof the validity of all the patents owned or controlled by the plaintiff and that the claims of several of them of Patents Nos.:

Re.16,461	1,798,962	2,015,327
Re.19,744	1,833,085	2,022,514
Re.19,823	1,857,055	2,041,273
1,382,738	1,878,614	2,041,291
1,405,523	1,892,354	2,080,646
1,572,504	1,913,604	
1,614,136	1,920,743	
1,710,035	1,927,672	
1,755,114	1,951,685	
7,755,115	1,958,027	
1,763,380	1,991,221	

cover all the radio broadcast receivers of sound which the defendant has manufactured and sold since October 1, 1935, and which the defendant is now manufacturing and selling.

That the defendant is hereby enjoined from selling or in any manner disposing of any radio broadcast receivers of sound which embody and employ the inventions or patents owned and controlled by the plaintiff as herein set forth without properly marking same as required by said license agreement.

By the Court, (Giles, J.)

CLESSON S. CURTICE
Asst. Clerk

Entered Dec. 3, 1941.

Copy,

Attest:—

JOSEPH R. CLEARY,
Ass't Clerk.

Same letter to:

Ansley	Majestic	Setchell-Carlson	Noblitt-Sparks
Automatic	Midwest	Sparks-Trav-ler	Farnsworth
DeWald	National	Warwick	Stromberg-Belmont
Electrical	Philharmonic	Watterson	Gilfillan
Espey	Phonovision	Wilcox-Gay	Mission Bell
Fada	Radia	Zenith	Philco
Garod	RCA (Schaine- (Hartman- (Morton		
General			
Hallicrafters			
Hamilton	Radio Mfg.	G.E.	
Harvarlund	Radio Prod.	Stewart-Warner	
Howard	Remler	Wells-Gardner	
Kingston	Simplex	Galvin	

May 14, 1941

Jacob P. Lieberman, President
Air-King Products Company, Inc.
1523-29 Sixty-Third Street
Brooklyn, New York

Dear Mr. Lieberman:

This letter will confirm that on May 12, 1941, the United States Supreme Court rendered a decision in the case of Hazeltine v. Zenith, holding Wheeler Reissue patent 19,740 invalid and not infringed by Defendant's apparatus.

Further, on May 9, 1941 Judge Fields, of the District Court of Delaware, handed down a decision in the case of Hazeltine v. General Motors holding Trube patent No. 2,111,183 invalid and not infringed by Defendant's apparatus. An appeal from this decision is under consideration.

With every good wish,

Sincerely yours,

HAZELTINE CORPORATION

By _____
Vice President-Treasurer

JBrah

[redacted]

Exhibit R 2.

AUTOMATIC RADIO MANUFACTURING CO. INC.

[illegible] AIRCRAFT MARINE RADIO APPARATUS

[illegible] BOSTON, MASSACHUSETTS

May 16, 1941

Mr. Jack Binns
Haseltine Corporation
15 Exchange Place
Jersey City, N. J.

Dear Mr. Binns:

I note from your letter of May 14th that the United States Supreme Court has rendered a decision in the Wheeler Patent in favor of the Detrola Co.

In view of the fact that it has been our understanding that this particular Patent is practically the only one under which we operate, we would like to know how we are affected by this decision.

Please advise so that we may govern ourselves accordingly.

With kindest regards and best wishes,

Cordially yours,

AUTOMATIC RADIO MFG. CO. INC.

DH:B

[illegible]

[illegible] attached to and forming
[illegible] the Affidavit of John R. Binns
[illegible] Action 6677

AFFIDAVIT OF HAROLD A. WHEELER

[Filed November 10, 1947.]

STATE OF NEW YORK
COUNTY OF NEW YORK ss.:

Harold A. Wheeler, being duly sworn, deposes and says:

1. That he graduated from George Washington University in 1925, with a degree of Bachelor of Science in Physics and continued post-graduate work for three years thereafter in the Physics Department of Johns Hopkins University; that he has been active in the development, design and testing of radio communication apparatus, particularly radio broadcast receivers, since 1921; that he has a practical familiarity with patents in the radio field having been granted some 139 patents in his own name and having served as an expert and fact witness in numerous patent litigations; that he is at present a consulting radio physicist having a laboratory at 259-09 Northern Boulevard, Great Neck, Long Island, New York;

2. That he has examined the circuit diagrams of the radio broadcast receivers identified as Exhibits B-N, inclusive, attached to plaintiff's answers to defendant's interrogatories filed herein on May 27, 1947, and the circuit diagrams identified as Diagrams A-J, inclusive, involved in an action between plaintiff's predecessor, Hazeltine Corporation, and defendant herein in the Massachusetts Superior Court for Suffolk County, Equity No. 47229, and, further, he has familiarized himself with the patents referred to in plaintiff's answer to interrogatory No. 2 filed May 27, 1947, and has compared the circuits described and claimed in such patents with aforesaid Diagrams A-J, inclusive, involved in aforesaid action Equity No. 47229 and with aforesaid circuit diagrams Exhibits B-N, inclusive, involved herein; that it is shown by such circuit diagrams that the radio broadcast receivers now being manufactured and sold by defendant as represented by aforesaid circuit diagrams Exhibits B-N, inclusive, are, in the respects noted hereinafter, the same as those found to embody

certain of the inventions of patents owned by plaintiff's predecessor, Hazeltine Corporation, in a final decree entered on or about December 3, 1941 in aforesaid action, Equity No. 47229 and, further, that the radio broadcast receivers now being manufactured and sold by defendant as represented by aforesaid circuit diagrams Exhibit B-N, inclusive, embody each of the elements of certain of the claims of such patents as follows:

(1) The oscillator—modulator circuit of each of the models of radio broadcast receivers enumerated in plaintiff's answer to interrogatory No. 2 filed herein May 27, 1947, is in all material respects the same as that of each of the several broadcast receivers identified at page 2, last three lines, of aforesaid final decree, Exhibit R, as Diagrams B, C, 5 Tube Super Midget (Diagram D), and Models S-6 (Diagram F) J-50, J-60 and A-5 (Diagram I) and J-80 (Diagram J), certified copies of which diagrams are attached hereto as Exhibits S-X, inclusive, which receivers were held to constitute infringements of these same patents, and embodies each of the elements of claims 3, 15, and 17 of patent 1,958,027, a copy of which is attached hereto as Exhibit Y and also embodies each of the elements of all of the claims of patent 2,015,327, a copy of which is attached hereto as Exhibit Z;

(2) The detector and detecting and amplifying system of each of the models of radio broadcast receivers enumerated in plaintiff's aforesaid answer to interrogatory No. 2 is in all material respects the same as that of each of the several broadcast receivers manufactured by defendant and identified at page 2, lines 10–14, inclusive, of aforesaid final decree, Exhibit R, as Diagrams B, C, 5 Tube Super Midget (Diagram D), and Models J-50, J-60 and A-5 (Diagram I) and J-80 (Diagram J), certified copies of which diagrams are attached hereto as Exhibits S, T, U, W, and X, respectively, which receivers were held to constitute in-

fringements of these same patents, and embodies each of the elements of claims 1, 2, 3, 5, 6, and 8 of patent 1,951,685, a copy of which is attached hereto as Exhibit AA and also embodies each of the elements of all of the claims of patent 2,041,273, a copy of which is attached hereto as Exhibit BB;

3. That the oscillator—modulator circuits and devices embodies in the above-mentioned radio broadcast receivers of defendant and described and claimed in aforesaid patents 1,958,027 and 2,015,327 are features essential to the construction of current commercial receivers of the superheterodyne type, which is the type in general use, while the detector and detecting and amplifying system embodied in the above-mentioned radio broadcast receivers of defendant and described and claimed in aforesaid patents 1,951,685 and 2,041,273 are essential features of all current commercial broadcast receivers.

HAROLD A. WHEELER.

Sworn to and subscribed before me, this twenty-seventh day of October, 1947.

PEGGY COYLE,
Notary Public.

Commission Expires March 30, 1948

[SEAL]

COMMONWEALTH OF MASSACHUSETTS

Suffolk, ss. Superior Court.

No. 47229 Equity.

HAZELTINE CORPORATION

vs.

AUTOMATIC RADIO MFG. CO.

I hereby certify that the photostats attached hereto are true copies of original diagrams appended to interrogatories propounded by the plaintiff to the defendant, in the above entitled action.

EDWARD J. KELLEY,
Ass't Clerk.

[SEAL]

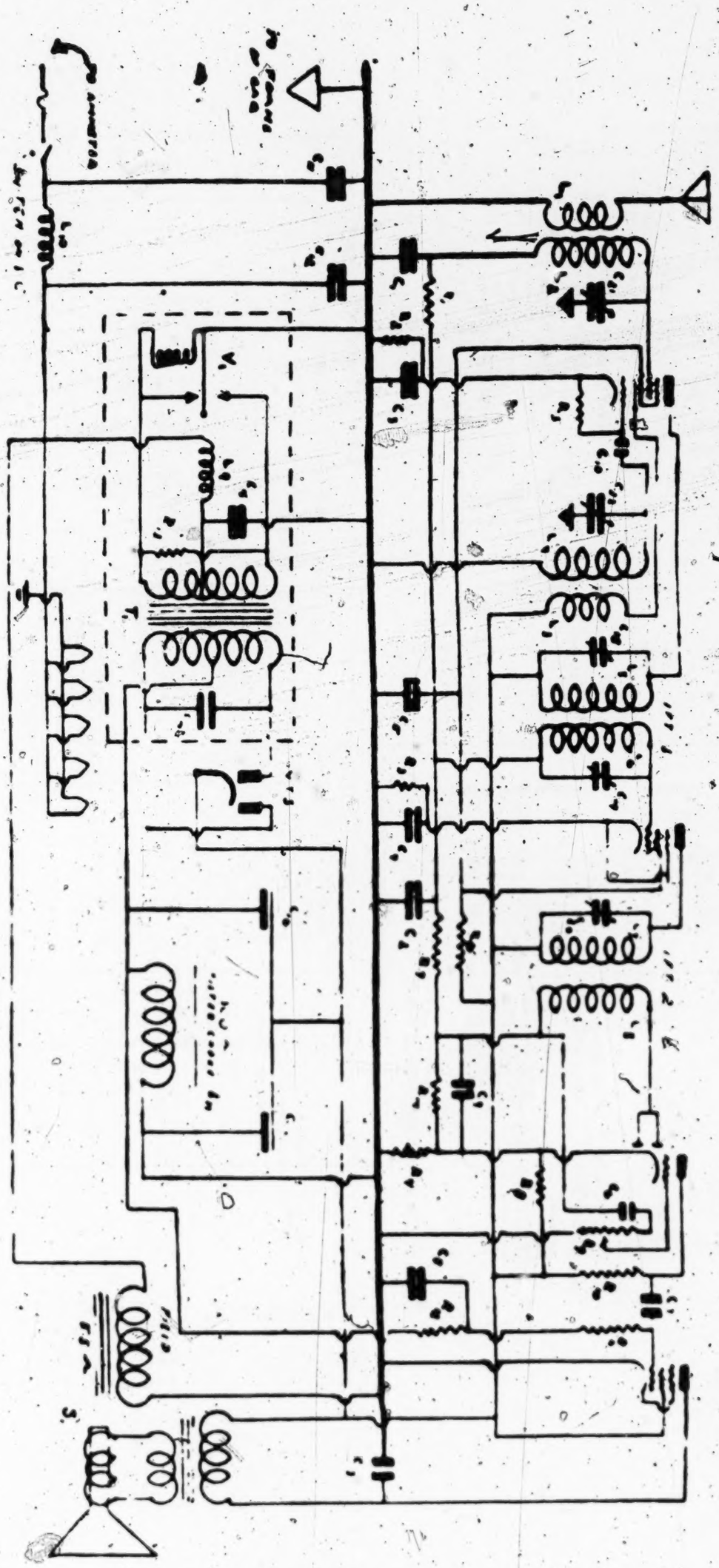


Diagram B..

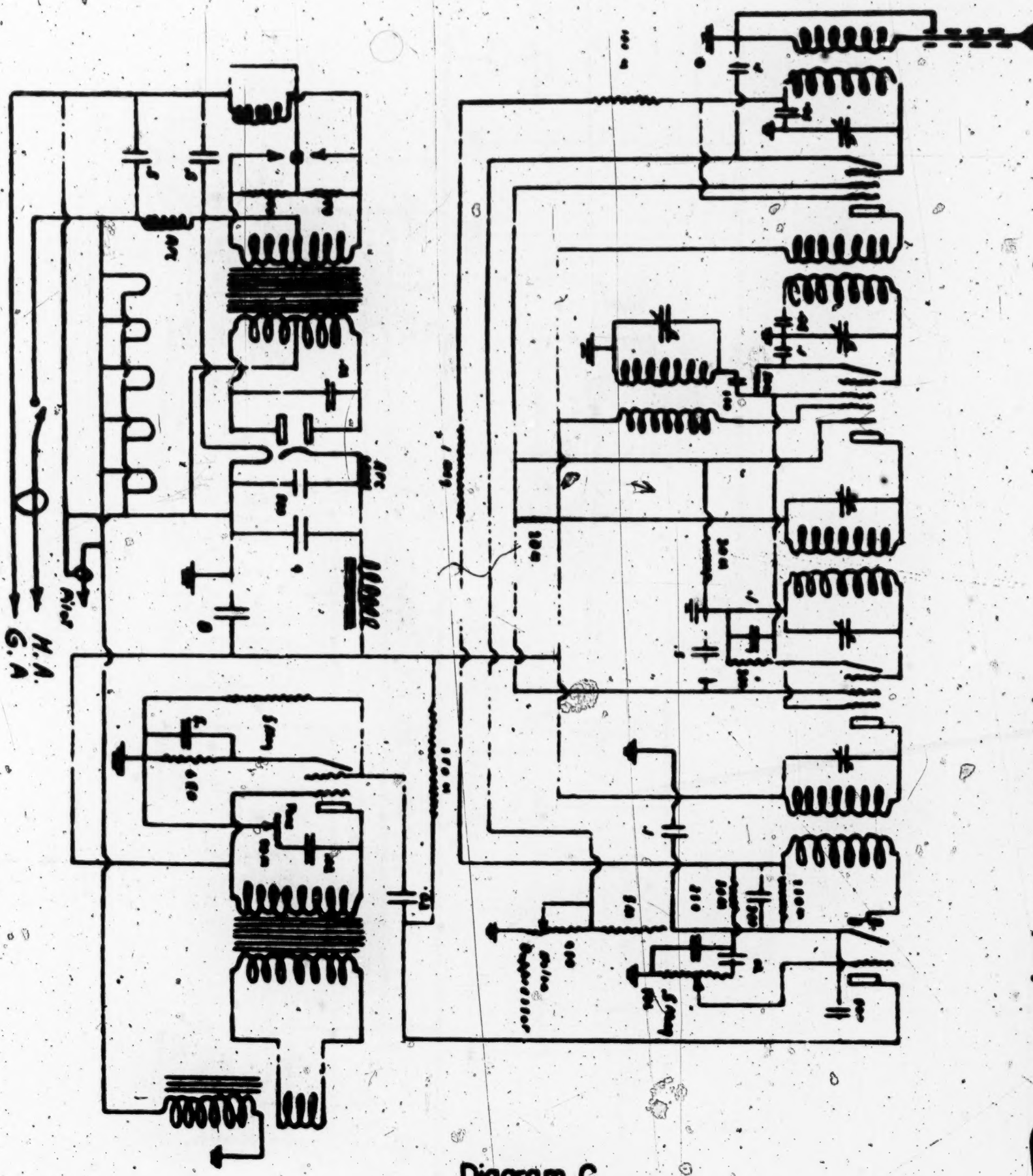


Diagram C.

AUTOMATIC 5 TUBE SUPER MIDGET

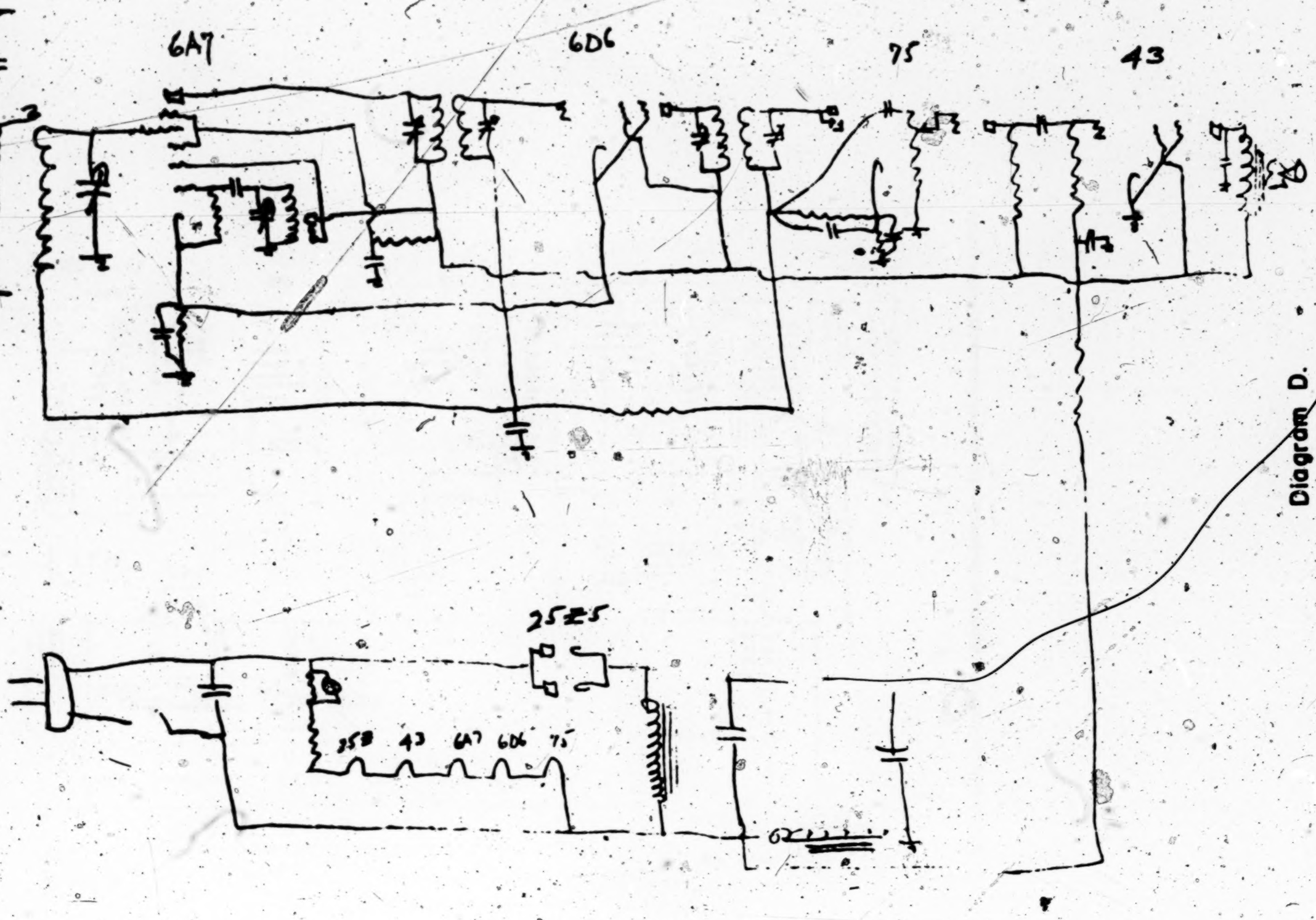
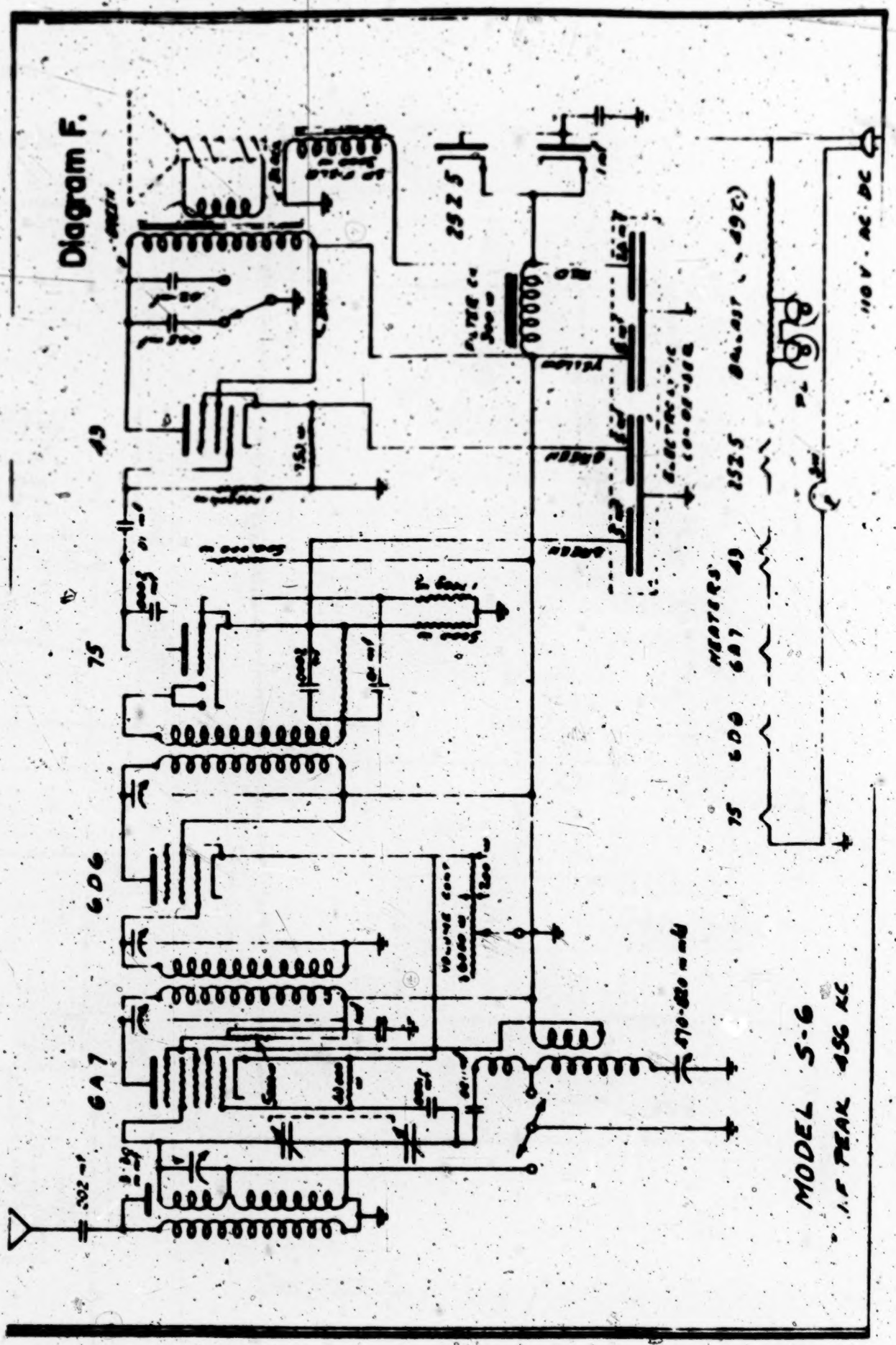


Exhibit U. Diagram D.

Exhibit V.

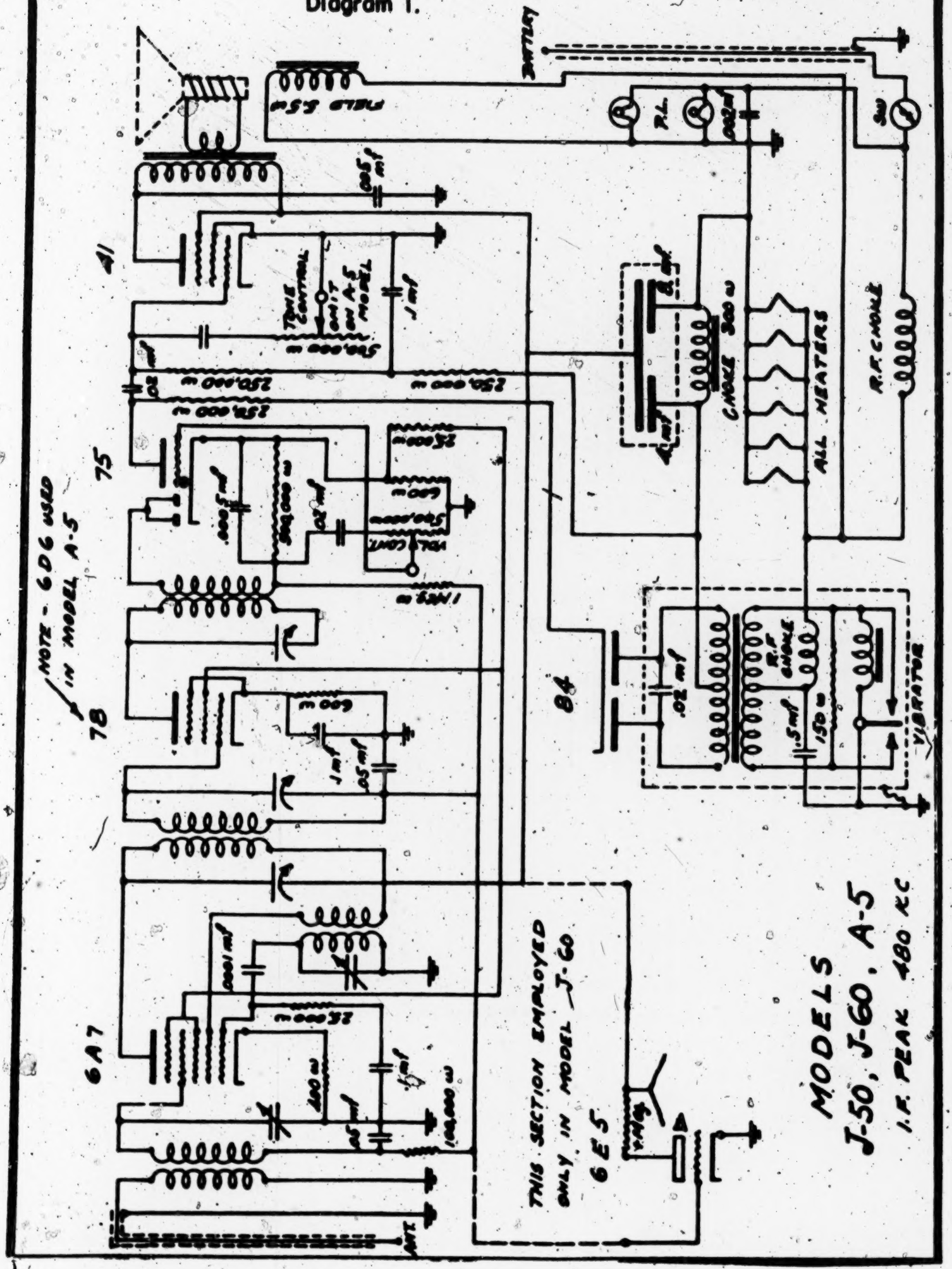


AUTOMATIC PAGE 7-8

AUTOMATIC RADIO MFG. CO., INC.

MODELS J-50, J-60
A-5
Schematic

Diagram 1.

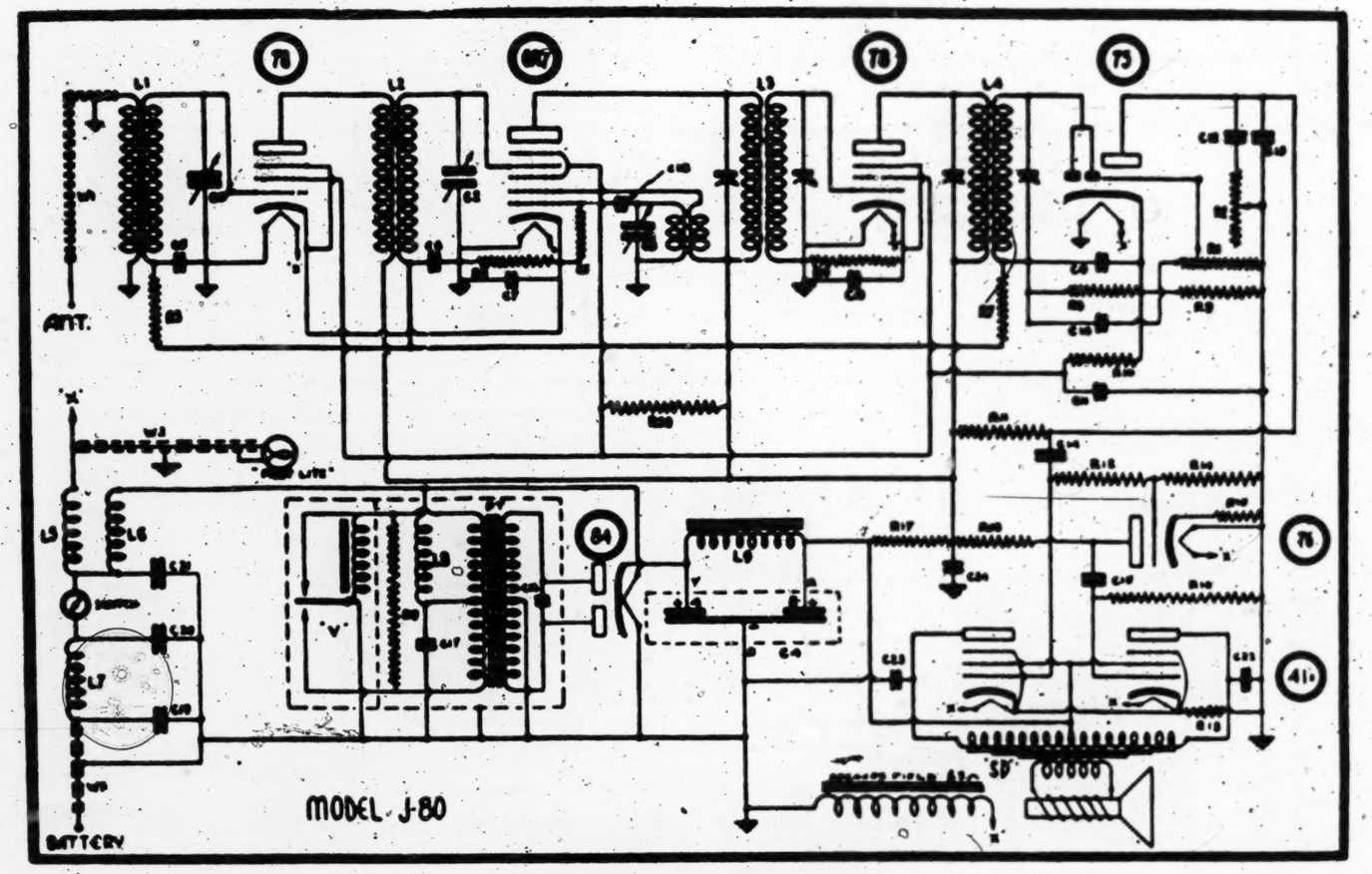


MODEL J-80
Schematic, Parts
Alignment

AUTOMATIC RADIO MFG. CO., INC.

MODEL J-80 AUTO RADIO

Diagram J.



ALIGNMENT PROCEDURE

I. F. Alignment. Connect a signal generator set at 450kc to the 6A7 input and connect an output meter to the speaker output. Using a weak signal tune the two I. F. condensers on the composite coil and the two I. F. condensers on the output I. F. coil for maximum response.

Connect the signal generator set at 1400kc to the antenna lead using a dummy antenna of 150 mmf. Tune the set by means of the dial to 1400kc position. Adjust oscillator trimmer for this frequency. Then

Exhibit Y attached to and forming part
of Affidavit of Harold A. Wheeler
Civil Action 6677

130

May 8, 1934. H. A. WHEELER 1,958,027

EMISSION VALVE MODULATION SYSTEM

Filed Jan. 30, 1933 3 Sheets-Sheet 1

Fig. 1.

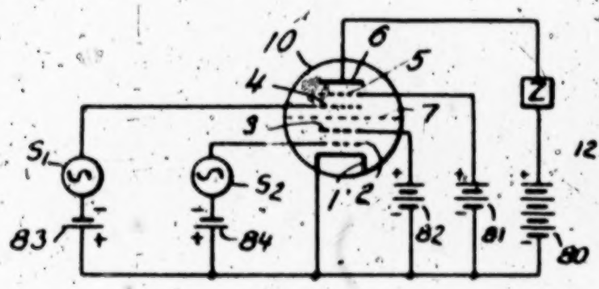


Fig. 4.

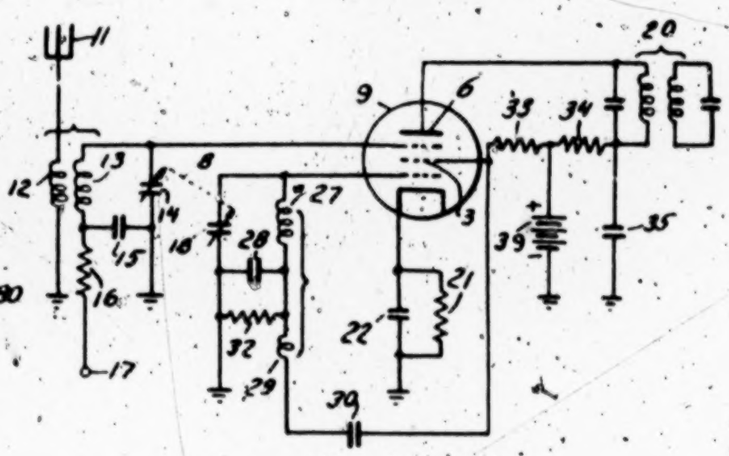


Fig. 2.

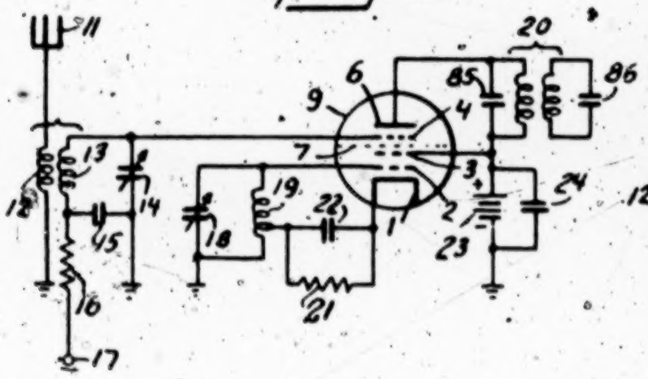


Fig. 5.

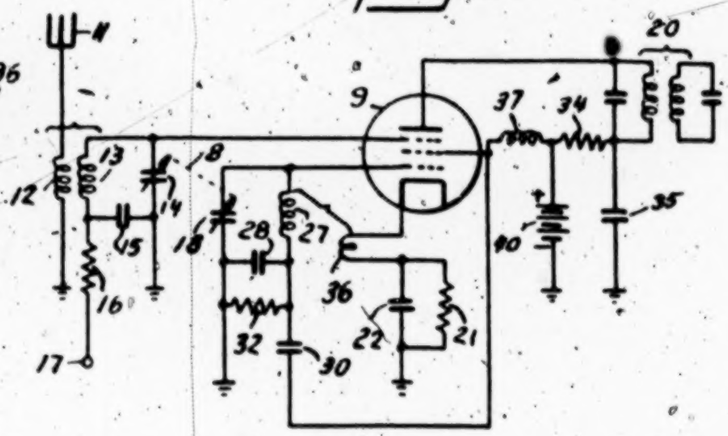


Fig. 3.

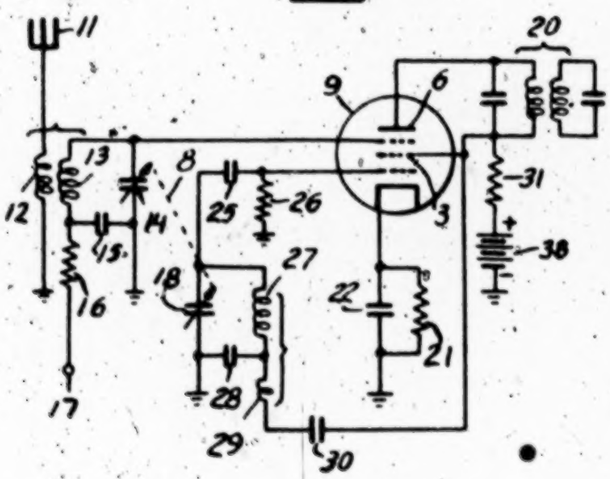
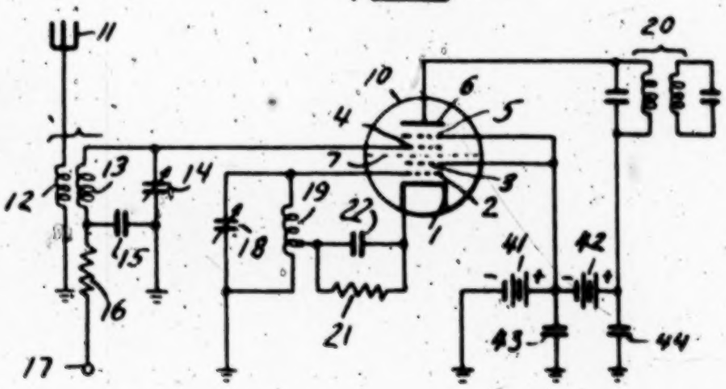


Fig. 6.



INVENTOR
Harold A. Wheeler
BY
Pennie, Davis, Marvel & Wood
ATTORNEY.

May 8, 1934. H. A. WHEELER 1,958,027

EMISSION VALVE MODULATION SYSTEM

Filed Jan. 30, 1933 3 Sheets-Sheet 2

Fig. 9.

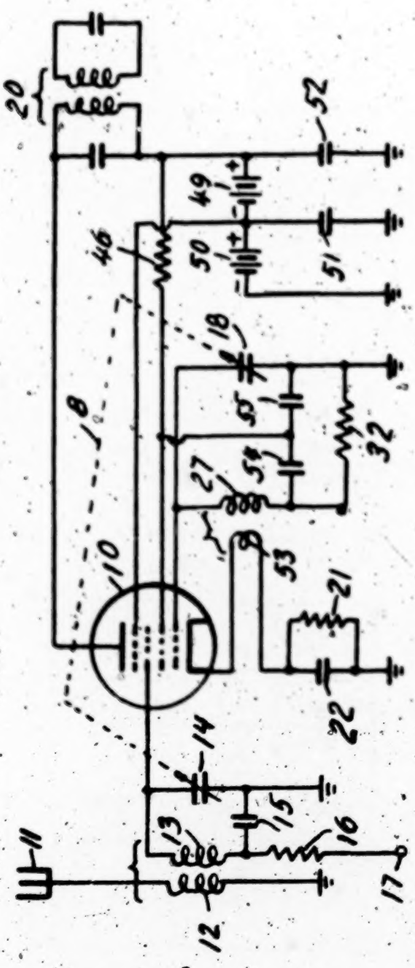


Fig. 11.

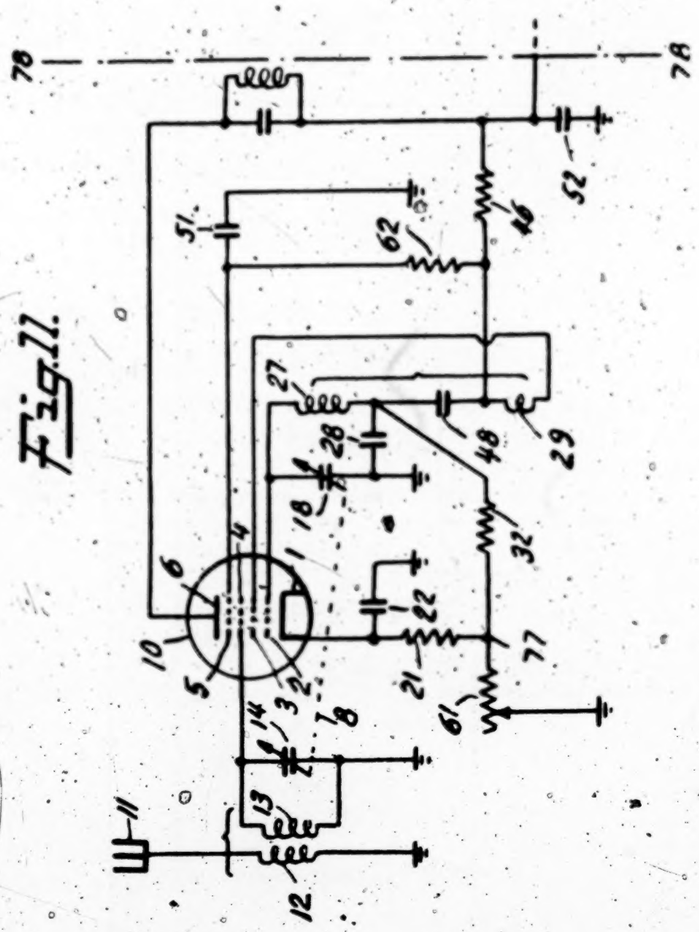


Fig. 7.

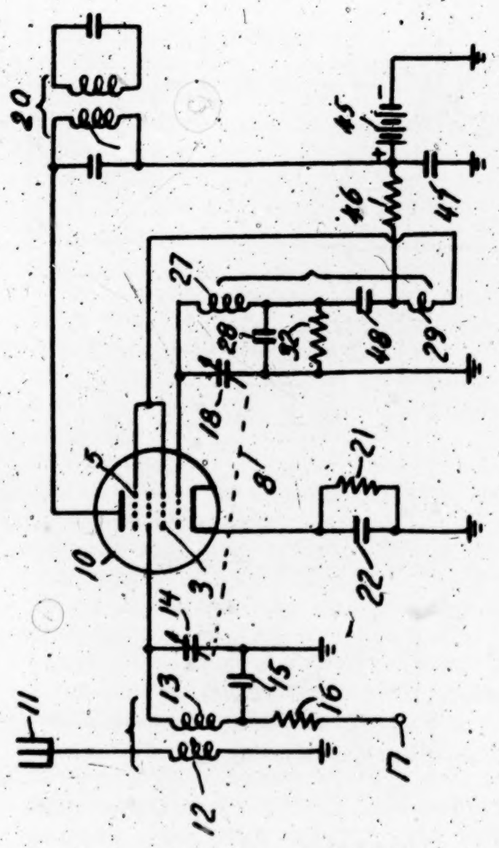
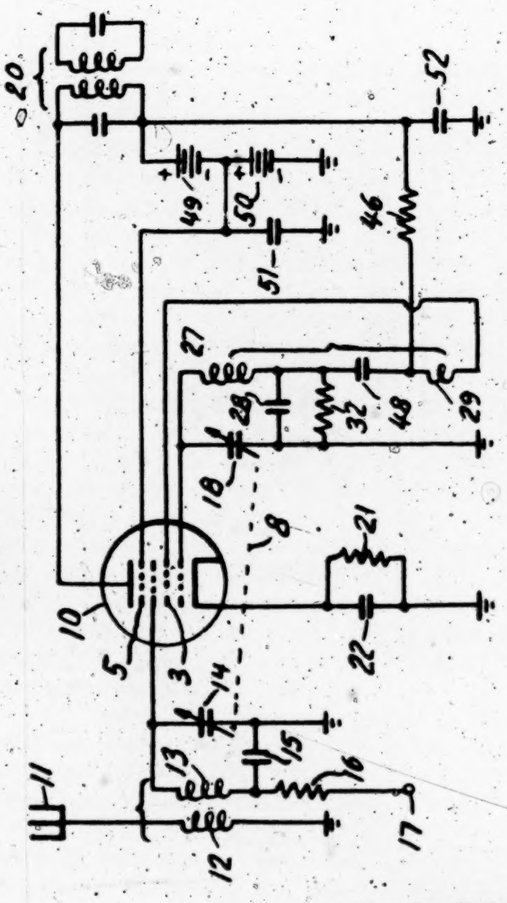


Fig. 8.



INVENTOR
Harold A. Wheeler
BY
Pennie, Davis, Marvin and Edmonds
ATTORNEYS

May 8, 1934. H. A. WHEELER 1,958,027

EMISSION VALVE MODULATION SYSTEM

Filed Jan. 30, 1933 3 Sheets-Sheet 3

Fig. 10.

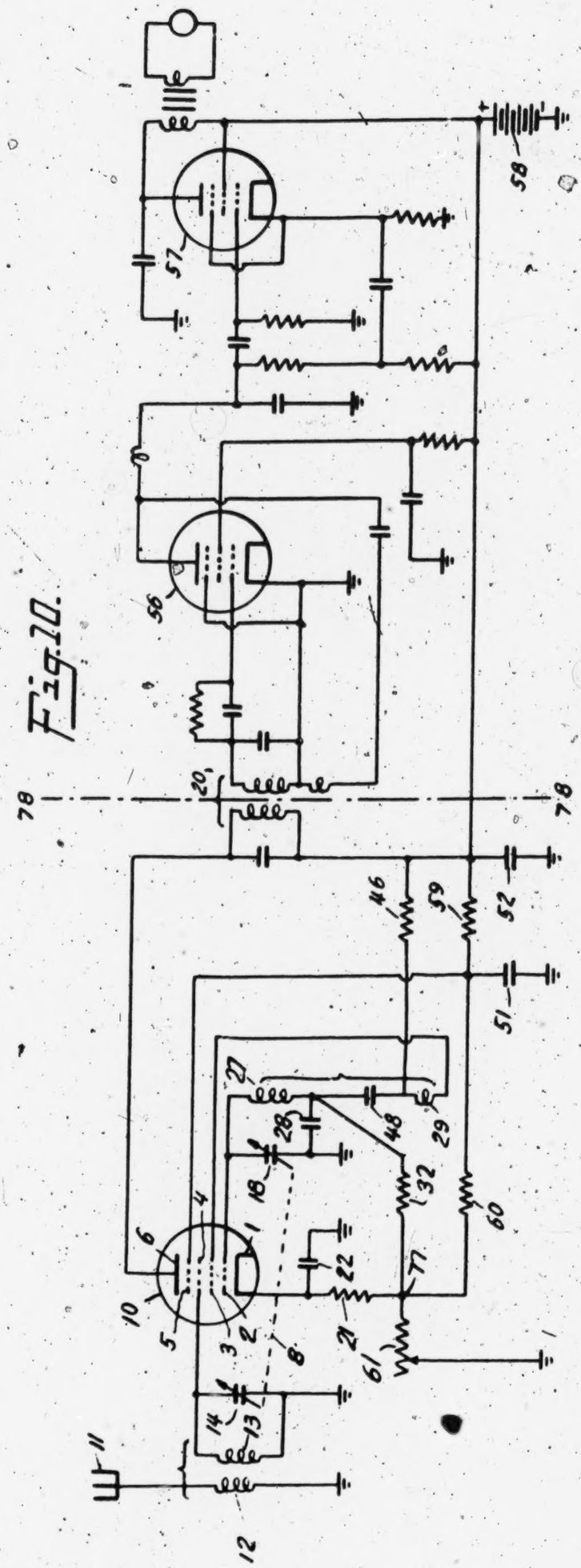
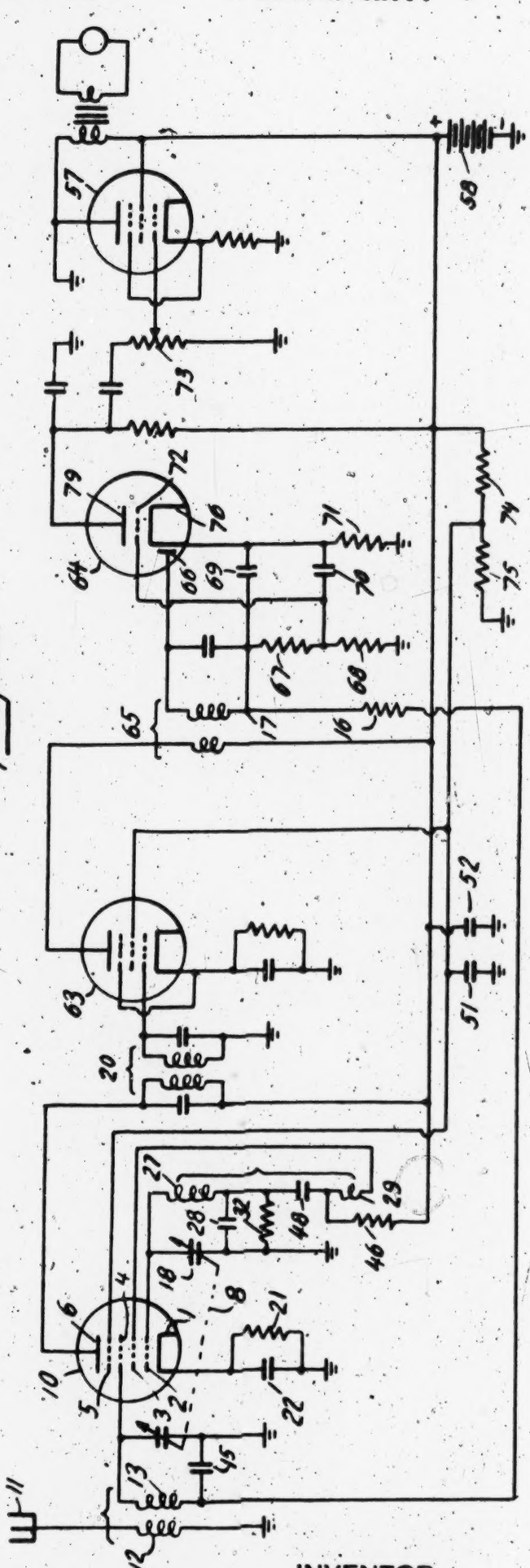


Fig. 12.



INVENTOR
Harold A. Wheeler
BY
Penne, Davis, Marvin and Edmonds
ATTORNEYS

Patented May 8, 1934 1,958,027

UNITED STATES PATENT OFFICE

1,958,027

EMISSION VALVE MODULATION SYSTEM

Harold A. Wheeler, Great Neck, N. Y., assignor to Hazeltine Corporation, a corporation of Delaware

Application January 30, 1933, Serial No. 654,326

19 Claims. (Cl. 250—20)

This invention relates to vacuum tube circuits, and more particularly to circuits for controlling the electronic flow in vacuum tubes.

In the use of thermionic vacuum tube circuits, particularly radio receiving circuits, it is common practice to impress alternating signal voltage upon the input electrodes of a tube and to apply another oscillating voltage in such a way that the currents at the output of the tube are modulated. An example of this type of modulation is found in the well-known vacuum tube valve modulator system.

The invention is preferably effected by utilizing a tube having a cathode, an anode and a modulator control grid therebetween upon which is impressed a source of signal voltage. Whereas the actual cathode furnishes the electron emission for the entire tube, the modulator control grid operates more directly on the virtual cathode, which is a cloud of electrons transferred from the cathode to a position nearer the modulator control grid. The virtual cathode is formed just outside of a screen located between cathode and modulator control grid, this screen being held at a positive voltage relative to the actual cathode. The number of electrons reaching the virtual cathode is controlled, and hence its density is caused to fluctuate, by the valve action of an inner control grid located between the actual cathode and the virtual cathode.

An important embodiment of this invention lies in its application to a combined oscillator and modulator. In this arrangement, the screen is inserted in the space path between the inner and outer control grids, the screen acting also as the anode of an oscillator. Thus, the device has, in effect, two anodes with the outer or modulator control grid situated therebetween. An appropriate oscillatory circuit is associated with the cathode, the inner control grid and the screen to produce the oscillations. The effect thus produced in the space path causes by its valve action a modulation of the signal voltage impressed upon the outer or modulator control grid; there is thus provided an oscillator-modulator requiring the use of only one tube having a single actual cathode in a unitary electrode structure. An advantage of this form of oscillator-modulator lies in the fact that only a single tube is required to perform the two functions of producing oscillations and modulation. Although these two functions have previously been performed in a single tube, they have not been performed by controlling the properties of a virtual cathode, as ume control is employed.

A particular advantage is realized in the oscillator-modulator form of the invention when a varying biasing potential, such as that of an automatic volume control is used to control the output of the modulator; for the control can readily be applied to the outer control grid or to some other outer electrode without affecting the performance of the oscillatory system.

A very useful form of the invention is one which utilizes a modulator tube in which there is provided a modulator control element which provides a "gradual cut-off"; that is, the characteristic of gain versus biasing potential has the form of a gradual curve. This is generally known as a "variable-mu" characteristic, and may have an exponential variation.

The various embodiments of the invention may conveniently be carried out by the use of an emission-valve modulator tube having five or six, or more, electrodes.

The output of the modulator system can be greatly increased by the use of an outer positive screen in the modulator section of the tube, between anode and outer control grid.

The term "grid" or "grid-like electrode" as used in this specification and in the claims denotes an electrode by, or through, which electrons may pass. The term "screen", as used in the specification and claims, denotes an electrode by, or through, which electrons may pass and which is ordinarily maintained at a sub-

DISCLAIMER

1,958,027.—*Harold A. Wheeler*, Great Neck, N. Y. EMISSION VALVE MODULATION SYSTEM. Patent dated May 8, 1934. Disclaimer filed September 25, 1940, by the inventor; the assignee, *Hazeltine Corporation*, assenting.

Hereby enters this disclaimer to claims 1, 2, 4 to 14, inclusive, 16, 18, and 19 of said patent.

[*Official Gazette October 22, 1940.*]

stantial positive potential with respect to the actual cathode.

The above and other features and advantages of the invention will become more apparent from the following detailed description when considered with the accompanying drawings of which:

Figure 1 is a schematic circuit diagram illustrating the principles and operation of the invention;

Fig. 2 illustrates an oscillator-modulator system in accordance with the invention, employing a pentode tube coupled to an antenna, the tube circuit being arranged to produce self-oscillations;

Fig. 3 shows a system similar to Fig. 2, but varying in details of the oscillatory system;

Figs. 4 and 5 show systems somewhat similar to Fig. 3, but differing therefrom in providing different operating potentials for the anode and for the oscillator screen;

Fig. 6 illustrates an arrangement similar to Fig. 2 except that a hexode tube is employed instead of the pentode of Fig. 2;

Fig. 7 is in general similar to Fig. 3, but employs a hexode type of modulator tube;

Fig. 8 is similar to Fig. 7, but in this arrangement the modulator screen is provided with a voltage different from that of the oscillator screen;

Fig. 9 shows a system like Fig. 8 except for details in the oscillator feedback arrangement;

Fig. 10 illustrates a complete superheterodyne radio receiver employing a manual grid bias type of gain control applied to a hexode oscillator-modulator system in accordance with this invention;

Fig. 11 shows the oscillator-modulator portion of the receiver of Fig. 10 to the left of dividing line 78—78, which may be used if desired instead of the arrangement shown in Fig. 10; and

Fig. 12 shows a complete superheterodyne receiver equipped with an automatic volume control system applied to the modulator control grid of a hexode oscillator-modulator system in accordance with this invention.

Figure 1 is a schematic circuit diagram presented to illustrate the principle and operation of the circuit of the invention in a generalized way. There is shown an emission-valve modulator tube 10 provided with an electron-emitting cathode 1, and an anode 6. In the space path between the cathode and anode there are placed four grid-like electrodes 2, 3, 4 and 5, these four electrodes being situated in the space path at increasing distances, in the order named, from the cathode toward the anode. The schematic diagram shows the cathode and anode located at opposite sides of the tube, but this conventional form of illustration is only for the purpose of schematic representation. Any tube actually used for this purpose would be likely to have a more orthodox construction, such as a centrally located cathode, helical grids surrounding the cathode, the successive grids having increasing diameters with respect to each other, and an anode in the form of a cylindrical plate surrounding the grid structures, such as that described in my copending application Serial No. 654,327 filed concurrently herewith.

A source of signals, designated S_1, is connected between the grid 4 and the cathode 1, while a source of local oscillations S_2 is connected between the grid 2 and the cathode. The output circuit of the tube is designated Z and is connected to the anode 6 and the cathode. For the purpose of rendering the system operative, there are provided sources of operating voltage making anode 6 and screens 5 and 3 positive relative to cathode. There are also provided voltage sources making grids 4 and 2 negative relative to cathode. Batteries 80, 81 and 82 represent sources of positive voltage for anode 6, screen 5 and screen 3, respectively; and batteries 83 and 84 indicate sources of negative potential for grids 4 and 2, respectively.

The positive voltage on screen 5 should generally be less than that on anode 6 with respect to the cathode. This screen may often be omitted, but in many embodiments of the invention its inclusion serves to improve the general operation.

In the operation of the above-described system, electrons emitted from the cathode 1 are attracted through the meshes of grid 2 to the screen 3, by virtue of the positive voltage applied to the latter. The electrons approaching screen 3 are traveling at high speed and most of them, therefore, pass on through the screen and approach the grid 4 which is ordinarily negative. The grid 4 therefore serves to retard the progress of the electrons and many of them are attracted back toward the positive screen 3. This cloud of retarded electrons hovering between the electrodes 3 and 4 may be said to constitute a "virtual cathode" with respect to the succeeding electrodes 4, 5 and 6 of the modulator, because of the fact that electrons can be easily drawn away from the cloud in the same manner that they were originally drawn away from the actual cathode. Electrodes 3 and 4 are a pair of electrodes relatively close together, the said electrode nearer the actual cathode having impressed thereon a substantially more positive voltage than the other of said electrodes. The "virtual cathode" and its approximate position is indicated by the dotted line 7, it being understood that the line 7 does not represent a physical element of the tube. The positive potential of the anode 6 and screen 5 serve to attract electrons from the virtual cathode to the anode, through the input grid 4 and the screen 5, in the usual manner. The tube therefore has, in effect, two anodes, namely elements 3 and 6, with the inner grid alone controlling the entire emission from cathode 1 and the space current to both anodes. It will therefore be observed that the electrodes 4, 5 and 6 together with the virtual cathode 7 function as an ordinary signal translating vacuum tube of which the input circuit is the source S_1 and the output circuit Z is connected between anode 6 and the "virtual cathode" (in so far as alternating currents are concerned). The signal translating electrodes are 4 and 6.

Modulation results in the system in the following manner. When the grid 2 is only slightly negative, or is somewhat positive, there is an abundant supply of electrons at the virtual cathode 7 available to supply an electron stream in the modulator section of the tube. When the grid 2 swings considerably negative, the virtual cathode, and therefore the anode 6, are momentarily deprived of their electron supply, thereby interrupting the output current. It will be observed, then, that the output current of the modulator varies in accordance with the oscillations of source S_2. This is the valve action by which the oscillations from source S_2 modulate the signals from source S_1 in the tube, producing the well-known beat note in the output circuit, hav-

ing a frequency equal to the sum or difference of the source frequencies.

The elements of the tube, other than the actual cathode, may be considered to be situated in two groups: (1) elements 4, 5 and 6 associated with source S_1; and (2) elements 2 and 3 associated with source S_2. The elements within each group are mutually adjacent, but all the elements of group (1) lie beyond those of group (2).

It is possible to control the output or conversion gain of the modulator over a wide range of intensities by varying the negative bias applied to the modulator grid 4. It will be observed that this type of control does not materially affect the behavior of the oscillatory portion of the system because the grid 4, regardless of its potential, is incapable of cutting off the electron current to the oscillator screen 3, which is the current required to maintain oscillations. It is therefore an easy matter to effect automatic volume control by automatically biasing modulator grid 4 more negative when the received signal strength increases. This type of automatic volume control is shown in detail in subsequent figures.

The operation of the system can often be improved, particularly when a bias operating volume controlling system is applied to modulator grid 4, by making this modulator grid of the "variable-mu" or "gradual cut-off" type. This can be easily done, for example, by constructing the grid 4 with a mesh which varies from one end to the other. The result is that the modulator is provided with a characteristic of gain versus grid bias which is in the form of a gradual curve, such as an exponential curve. This kind of grid gives a gradual variation of space current when the bias voltage is varied; and there is a very gradually changing output with varying bias voltage, over a wide range of output and bias voltages. This type of characteristic permits a wide range of negative biasing potentials to be employed, even very high negative potentials, without rendering the modulator inoperative or subject to excessive distortion.

The reason for the above satisfactory results can be readily shown by considering what would happen in the case of a "constant-mu" or "sharp cut-off" tube. In such a case, a high negative biasing potential produces operation below the relatively sharp bend of the tube characteristic curve, whereupon variations of the anode current are greatly reduced and the tube is rendered inoperative.

Figure 2 illustrates an oscillator-modulator system constructed in accordance with this invention, employing a pentode or five-electrode type of signal translating tube 9 which is similar to the hexode or six-electrode tube 10 of Fig. 1, except that the screen 5 is omitted. The system is associated directly with the antenna system of a radio receiver. The antenna 11 is connected to ground through the usual form of antenna coil 12 which is inductively coupled with the tunable input circuit of the receiver, comprising the tuning condenser 14, a fixed condenser 15 and an inductance 13, the latter being coupled to the antenna coil. The tunable input circuit is connected with the modulator control grid 4 of the oscillator-modulator tube 9 and is likewise effectively connected through ground to the cathode 1 of the tube, by virtue of the grounding of the cathode system through resistance 21, condenser 22, and the lower end of a coil 19.

A portion of the tube 9 likewise forms an integral part of an oscillatory system which comprises a tuned oscillatory circuit including inductance 19 and a variable condenser 18, this oscillatory circuit being connected between the oscillator grid 2 and the cathode 1. For the purpose of producing an electron flow from the cathode, and also to complete the oscillatory system, the oscillator screen 3 is connected through the voltage source 23, shunted by a bypass condenser 24, to ground; so that there is a complete circuit from the screen 3 through ground to the cathode 1, through part of coil 19 and the condenser-resistance connection 22, 21. The mutual inductance between the two portions of coil 19, and also condenser 18, constitute an oscillation-producing feed-back coupling because they are common to the cathode-screen circuit and the cathode-grid circuit of the oscillator, so there is produced feedback of energy from the screen 3 to the oscillator grid 2 which produces constant sustained oscillations. The auxiliary electrodes 2 and 3 may therefore be designated the oscillation-producing electrodes, or means for modulating the signal. It will be observed that in so far as the oscillatory system is concerned, the screen 3 acts as an anode. It is noted that the control grid and anode are located in the space path beyond said oscillation-producing electrodes.

By virtue of the negative bias applied to control grid 4, the "virtual cathode" exists at 7, from whence space path current flows to the modulator anode 6. The modulator anode circuit is completed through the primary winding of a modulator output transformer 20, and the voltage source 23 bypassed by condenser 24.

In operation, a signal voltage across the signal tuned circuit is impressed on the control grid 4, and modulation between the signal frequency and the frequency of the oscillatory system is produced by virtue of the valve action of the oscillator upon the electron emission stream. The oscillatory system is a means for causing the electron density of the virtual cathode to fluctuate periodically and thereby modulate the signal voltage. This may be called space path modulation. The resulting products of modulation appear across transformer 20 which lies in the modulated signal output circuit. In this case, the transformer 20 is tuned by the fixed condensers 85 and 86, across the transformer windings, to the well-known intermediate frequency produced in superheterodyne receivers, this intermediate frequency being the difference between the signal frequency and oscillator frequency.

Tube 9 may be subjected to gain control or volume control by applying a bias control voltage to grid 4 which is negative relative to cathode 1. One way of connecting this bias voltage is indicated in Fig. 2 as follows. The bias voltage is connected to point 17, and impressed on the amplification, or gain-control grid 4 through resistor 16 and coil 13. This constitutes a bias-voltage control of amplification; and the arrangement may be termed a bias controlled modulator stage. Condenser 15 prevents the flow of alternating currents in the bias circuit.

It is usually desirable to incorporate in radio receivers an automatic volume control system, now well-known in the art. Such a system is claimed and described in my United States Patent 1,879,863, issued September 27, 1932. In accordance with the operation of the automatic volume control system there is produced a uni-

directional bias voltage which varies with the tuned signal strength. This variable bias voltage is impressed upon a gain-control element of a vacuum tube. It is desirable to impress such an automatic volume control on oscillator-modulator tubes used in superheterodyne receivers, particularly in those receivers employing very few tubes, as where the oscillator-modulator tube is the first tube of the receiver, as shown in Figure 2. Figure 2 is accordingly adapted for this type of automatic volume control, the negative automatic volume control bias voltage, variable with the signal strength, being connected at terminal 17 and impressed upon the modulator control grid 4 through resistance 16.

Automatic volume control as applied to the system of Figure 2 is made practicable for the reason that the volume control bias is not applied to the oscillator grid 2, but only to the modulator control grid 4. In the previously known types of oscillator-modulator utilizing only a single tube, the oscillator grid and modulator grid are identical, or at least are interrelated in such manner that any biasing voltage applied to the control grid affects the oscillations, and even stops the oscillations when this grid becomes greatly negative.

Figure 3 illustrates a system quite similar to Figure 2, like elements being designated by the same numerals as in Figure 2. The system of Figure 3, however, has certain refinements or modifications not found in Figure 2. There is employed in the oscillator system a grid-leak 26 and grid condenser 25 which develop a negative average bias on the oscillator grid 2, relative to the cathode, which serves to limit the amplitude of oscillation and the oscillator grid current.

In place of the single tapped oscillatory coil 19 of Fig. 2 there is provided in Fig. 3 a pair of inductively coupled coils 27 and 29, the coil 27 being included in the oscillatory circuit. Feedback from the screen 3 (oscillator anode) is conveyed through a condenser 30 to coil 29 and fixed condenser 28 to ground, the condenser 28 and the coupling between coils 27 and 29 producing combined capacitive and inductive feedback in aiding phase. In this arrangement, the amplitude of oscillation is better sustained at the lower frequencies by virtue of condenser 28, and is preferably held uniform over the tuning range. The condenser 30 serves to convey the feedback currents and yet insulate the oscillatory circuit from the voltage source 38. A resistance 31 is provided to prevent the voltage source from shunting the feedback elements 28, 29 and 30.

Condenser 28 also makes possible the use of like condensers 14 and 18, ganged together by a uni-control device as indicated by the dotted line 8, while maintaining a uniform frequency difference between signal and oscillator circuits.

In this arrangement, the feedback voltage is incidentally applied to the anode 6, but this circumstance produces no great effect on the performance.

Figure 4 illustrates a system similar to that of Figure 3 but differing in two details. In Figure 4, the arrangement is such that the source of operating voltage 39 applies separate voltages to the anode 6 and to the screen 3, these different voltages being provided by means of resistances 34 and 33 connected respectively to the two electrodes 6 and 3, the battery 39 being connected to the other ends of these resistances which are joined together. Condensed 35 bypasses the resistor 34 and voltage source 39 in the anode circuit. In this figure, also, a grid leak 32 is connected across condenser 28 of the oscillatory circuit, and no separate grid condenser is required as in the case of Figure 3.

Figure 5 is similar to Figure 4 except that the feedback coil 29 of Fig. 4 is replaced by a coil 36 in series with the cathode and coupled to the inductance 27 in the oscillatory circuit. In this figure, also, a choke coil 37 is used to replace the resistance 33 of Fig. 4, the use of the choke coil in this position preventing a loss of operating voltage. This permits the use of a voltage source 40 having a lower voltage than source 39 in Fig. 4.

Figure 6 illustrates the embodiment of Figure 2 except that the hexode type of tube 10 is employed in place of the pentode tube 9, the extra electrode of tube 10 being the modulator screen 5 positioned between the modulator control grid 4 and the anode 6. In this embodiment, the same voltage source 41 is applied to the two screens 3 and 5. An additional voltage source 42 is used in series with source 41 and applied to the anode 6. The voltage sources are bypassed by condensers 43 and 44.

The arrangement of Figure 7 is generally similar to that of Figure 3, the main difference being that Figure 7 employs the hexode form of modulator tube 10. In this embodiment, the feedback coil 29 is separated from the oscillatory tuned circuit by a fixed condenser 48, this arrangement providing somewhat improved results. Oscillator screen current is supplied through resistor 46 from voltage source 45 bypassed by condenser 47. The screens 3 and 5 are provided with the same voltage. It will be noted that the feedback operates simultaneously on both screens, although this circumstance produces no great difference in the resulting performance.

It is sometimes desirable to impress different voltages on the two screens, in which case, the arrangement of Figure 8 may be employed, Figure 8 being similar to Figure 7 except for the use of the separate screen voltage for screen 5. Voltage source 45 in Fig. 7 is replaced by voltage sources 49 and 50 in series in Fig. 8, bypassed by condensers 51 and 52.

Figure 9 shows an arrangement which is in general similar to that of Figure 8, the principal feature of Figure 9 residing in the rearrangement of the oscillator feedback system. In Figure 9, two condensers 54 and 55, in series, are used to replace the feedback coupling condenser 28 of Figure 8, the condensers 54 and 55 therefore each being made larger than condenser 28, but having the same resultant capacity. The voltage across only one of the condensers, namely condenser 55, is used for capacitive feedback in the oscillator screen circuit. The inductive feedback, in this embodiment, is provided by the coil 53 in the cathode lead, coupled to the oscillatory tuned coil 27, as in the case of Figure 5.

Figure 10 illustrates a complete superheterodyne receiver employing a hexode oscillator-modulator system essentially like that of Figure 8. In this receiver, a manual amplification or gain control is provided in the form of a rheostat 61 connected between ground and a point 77 in the cathode circuit. When the rheostat 61 is adjusted for zero resistance, that is, for maximum gain, point 77 is grounded and the resulting circuit is exactly like that of Figure 8, in so far as the oscillator-modulator performance is concerned. A slight difference from the arrangement of Figure 8 lies in the use of two resistors 59 and 60 connected in series across the voltage source 58.

the modulator screen voltage being taken from the point between these resistors. This arrangement avoids the use of the two batteries 49 and 50 shown in Figure 8.

In the operation of the receiver, when the resistance of rheostat 61 is increased, the principal effect is to make the cathode voltage more positive with respect to ground, at the same time leaving the bias on modulator grid 4 connected to ground. The effect is that of placing an increased negative bias on the modulator grid relative to cathode, thereby reducing the gain of the tube. The general operation of the system is not otherwise affected by this manual gain control.

The remainder of the receiver is of a conventional type and comprises a second detector 56 having signal rectifying electrodes for developing the audio signals by rectifying the intermediate frequencies present in the output transformer 20 of the oscillator-modulator. An audio amplifier 57 having signal amplifying electrodes is coupled to the output of the detector 56 from whence the signals are utilized in any desired manner such as by a loudspeaker coupled to the output thereof.

Figure 11 illustrates a form of oscillator-modulator system well adapted for use in the receiver of Figure 10. In Figure 11, only that portion of the receiver to the left of the dividing line 78—78 in Figure 10 is shown. The oscillator-modulator of Figure 11 is very similar to that of Figure 10 with the exception that the biasing potential on the oscillator screen 3 is applied to the modulator screen 5 through a resistor 62 connected between the modulator screen and resistor 46. This arrangement obviates the use of the two resistors 60 and 59 of Fig. 10, but still prevents appreciable shunting of the feedback elements 28 and 48.

Figure 12 illustrates a superheterodyne receiver embodying the invention, complete with an automatic volume control system applied to the oscillator-modulator tube. The oscillator-modulator system is similar to that of Figures 8 and 10. The intermediate-frequency output transformer 20 serves to couple the oscillator-modulator 10 with an intermediate frequency amplifier 63. The output of amplifier 63 in turn is coupled through transformer 65 to a diode type of rectifier in tube 64. This tube is a well-known type of tube comprising both a diode and a triode having a common cathode 76, the diode elements being anode 66 and cathode 76, and the triode elements being cathode 76, control grid 72 and anode 79. A form of a satisfactory diode rectifier is more fully described in my above-mentioned Patent 1,879,863 and in my copending application Serial No. 526,857, filed April 1, 1931. The output of the diode detector is coupled to an audio frequency amplifier 57 in any well-known manner.

By virtue of the rectifying action of the diode detector, there is developed at point 17 a unidirectional rectified signal bias voltage which varies in accordance with the signal strength impressed upon the diode. When the signal strength increases, the rectified current flowing through resistances 67 and 68 makes the bias voltage of point 17 more negative with respect to ground. This bias is applied through resistor 16 and inductance 13 to the gain-control grid 4 of modulator 10, thereby biasing the modulator grid in proportion to the signal strength. As previously explained, the automatic volume control arranged in this manner is especially satisfactory since it does not noticeably affect the oscillatory system associated with the modulator.

Any of a number of circuits may be employed to produce the bias voltage at point 17 for automatic volume control. In Fig. 12 the voltage across the secondary coil of transformer 65 is impressed between the diode anode 66 and the point 17, the latter point being connected to the diode cathode 76 through resistors 67, 68 and 71 in series. These resistors are bypassed for radio-frequency currents by condensers 69 and 70, both having very high impedance at audio frequencies. The rectified audio-frequency voltage, freed of radio-frequency compounds, which exists across resistor 68, is connected to the grid 72 of the triode section of tube 64. The cathode 76 of tube 64 is biased positively relative to ground by resistor 71. This bias prevents grid current in tube 64 and also renders the diode inoperative at very small signal intensities where static or noise interference is objectionable. The audio voltage is amplified in the triode portion of tube 64, and applied from the anode 79 to voltage divider 73 which controls the volume level in the succeeding audio-frequency circuits, the volume level in tube 64 being controlled automatically.

Resistors 74 and 75 in series furnish a reduced positive voltage for the screens of tubes 10 and 63, relative to the anodes.

In the arrangements described herein, the precise structure and number of electrodes may be varied over a wide range. The diagrams indicate tubes of five and six electrodes (pentodes and hexodes). Additional electrodes may be provided without departing from the spirit of the invention and without destroying its advantages.

Pentode tubes of type 57 or type 58 are operative in the circuits of Figures 2, 3, 4 and 5. These tubes are characterized by having a cathode and an anode separated by three successive grid-like electrodes, the middle electrode being a screen of fine mesh, which serves well as the oscillator screen 3 in the pentode circuits described herein. The grid adjacent to the anode in these tubes has a uniform wide mesh and serves well as modulator control grid only in those cases where a wide range of gain control is not required in the modulator tube.

Best results are obtainable with special six-electrode tubes or hexodes. Referring to Fig. 1, grid 2 may be of uniform or varying mesh, but uniform mesh is generally preferred. Screens 3 and 5 are preferably of fine mesh. The preferred mesh of grid 4 depends on whether a high gain or a wide range of gain control is required. For high gain, grid 4 is preferably of uniform fine mesh. For a wide range of gain control, as with automatic volume control, grid 4 has preferably a non-uniform mesh varying from fine mesh at the ends to coarse mesh in the middle, that is, has a gradual cut-off characteristic.

There are a number of preferred circuit relations which improve the performance but are not essential in the circuits described herein. These relations will now be outlined.

The voltages on grid 4, screen 5 (if present) and anode 6 are preferably chosen to hold the average anode current less than one-half the average screen current, or less than one-third the average cathode current, the cathode current being substantially the sum of the screen and anode currents. This relation provides that changes in anode current have a negligible effect on the performance of the oscillator circuit.

The average negative bias on grid 2 relative to

cathode 1, which is provided by resistor 26 or 32 in Figures 3, 4, 5, 7, 8, 9, 10, 11 and 12, is preferably related to the voltage on the oscillator screen 3, to provide that the space current in the tube is substantially zero during the negative half-cycles of the oscillator voltage on grid 2, that is, the space current is periodically reduced to zero. For this purpose, the oscillator control grid 2 having the constant alternating voltage thereon should be of the common sharp cut-off type. This insures a complete valve action of the oscillator voltage as affecting the density of the virtual cathode and the performance of the modulator. This condition is referred to as "complete modulation" in the oscillator-modulator tube.

In Figures 3, 4, 5, 7, 8, 9, 10, 11 and 12, combined capacitive feedback 28 (55 in Fig. 9) and inductive feedback 29 (36 in Fig. 5 and 53 in Fig. 9) are utilized to maintain oscillations. These two feedback elements are preferably related to maintain the oscillation voltage on grid 2 nearly uniform over the tuning range. In the same figures, a condenser 30 or 48 (55 in Fig. 9) is shown in the feedback circuit. This condenser relative to all other elements in the oscillator screen circuit, is preferably proportioned to maintain the impedance between screen 3 and ground as small as possible without too far reducing the oscillator feedback or weakening the oscillations.

Figs. 2 and 6 have a negligible impedance in the oscillator screen circuit, the cathode and oscillator grid being associated with the oscillator tuned circuit in a feedback relation. This arrangement minimizes the coupling of oscillator currents to the tuned antenna circuit which would otherwise occur through inter-electrode capacitive coupling between grid 4 and screen 3. This arrangement, however, is somewhat less effective as a modulator circuit, compared with the other arrangements shown.

In Figs. 10, 11 and 12, it is noted that the bias between grid 2 and cathode 1 is distinctly independent of the volume-control bias between grid 4 and cathode. This feature is desirable in most cases and is often essential to the successful operation of the oscillator-modulator system in the presence of gain control means.

I claim:

1. In a modulation system, a vacuum tube comprising an actual cathode, means for producing a virtual cathode composed of a cloud of electrons, said means comprising a pair of electrodes relatively close together, the said electrode nearer said actual cathode having impressed thereon a substantially more positive voltage than the other of said electrodes, an anode near said virtual cathode, a grid between said anode and said virtual cathode, a source of signal voltage coupled to said grid, and means independent of said grid and anode for causing the electron density of said virtual cathode to fluctuate periodically and thereby modulate said signal voltage, said means comprising an electrode interposed between said actual cathode and said virtual cathode.

2. In a signal translating arrangement, an oscillator-modulator system comprising a cathode, an anode and a grid between said cathode and anode, a source of signal voltage coupled to said grid, an output circuit coupled to said anode, and oscillation-producing means for modulating said signal in said tube, said means including two auxiliary electrodes interposed between said cathode and said grid, the said auxiliary electrode furthest from said cathode having a positive voltage applied thereto, and a tuned circuit coupled between one of said auxiliary electrodes and said cathode.

3. In a modulator vacuum tube having a cathode and a gradual-cutoff control grid, means for effecting complete modulation which comprise a sharp cut-off control grid interposed between said cathode and gradual cut-off control grid, and a source of constant alternating voltage impressed on the interposed grid which periodically reduces to zero the space current of said vacuum tube.

4. In a signal receiving and translating arrangement, an oscillator-modulator system comprising a vacuum tube having a cathode, an anode and a first, second and third grid positioned in the space path in the order named, from said cathode to said anode, a source of positive voltage relative to said cathode impressed upon said second grid for creating an electron stream from said cathode, a signal input circuit connected between said third grid and said cathode, an output circuit connected between said cathode and said anode, and a tuned circuit connected to said cathode and coupled to said first and second grids for producing sustained oscillations.

5. In a superheterodyne receiver, an oscillator-modulator system comprising a vacuum tube having an actual cathode, an anode electrode and first, second and third grid-like electrodes located at respectively increasing distances from said actual cathode in the space path between said actual cathode and said anode, a voltage source impressing a positive voltage on said second electrode, and a voltage source impressing a negative voltage on said third electrode, whereby a virtual cathode with respect to said anode is created between said second and third electrodes, a tuned circuit system connected to said actual cathode and having oscillation-producing coupling to said first and second electrodes, and a source of signals connected between said third electrode and said actual cathode, and an output circuit connected between said cathode and an electrode located beyond said third electrode.

6. In a signal receiving and translating system, a bias controlled modulator stage comprising a vacuum tube having a cathode, an anode and at least two grids interposed between the anode and cathode, one of said grids having a variable-mu structure and having impressed thereon the signal voltage and the bias control voltage, said other grid having impressed thereon an alternating voltage, whereby space-path modulation is effected in said tube, means responsive to the output of said modulator for causing said bias voltage to automatically vary in proportion to the received signal intensity, whereby the output of said modulator stage is maintained more nearly constant than the input over a wide range of received signal intensities.

7. In a superheterodyne receiver, an oscillator-modulator system comprising a vacuum tube having a cathode and two oscillation-producing electrodes near said cathode, impedance means including a tuned circuit coupled between said two electrodes and connected to said cathode for producing sustained oscillations in said tube, said tube including a control grid and an anode located beyond the path between said cathode and said two oscillation-producing electrodes in said tube, a source of signal voltage coupled between said control grid and said cathode, and means for applying a bias control voltage on said control grid, whereby the anode current is controlled and any effects of the bias voltage on

the oscillations are minimized by the location of said grid and anode.

8. In a superheterodyne receiver, an oscillator-modulator system comprising a vacuum tube having a cathode and two oscillation-producing electrodes near said cathode, impedance means including a tuned circuit coupled between said two electrodes for producing sustained oscillations, said tube including a control grid and an anode located in the space path beyond said oscillation-producing electrodes, a source of signal voltage coupled between said control grid and said cathode, means for developing a bias control voltage which automatically varies with the intensity of said signal source and means for applying said bias voltage to said control grid, whereby the intensity of the modulated signal in the anode circuit is maintained more nearly constant than said signal voltage over a considerable range of signal voltage at said source, without substantially affecting the intensity of said oscillations.

9. A modulation system comprising a vacuum tube having a cathode, an anode and first, second and third grid-like electrodes interposed in the space path, in the order named, from said cathode to said anode, a signal input circuit connected between said third electrode and said cathode, a modulated-signal output circuit connected between said cathode and said anode, a source of positive voltage applied to said second electrode, a source of oscillations connected between said first electrode and said cathode, and means for applying a variable bias voltage upon said third electrode, whereby the output of said tube may be varied over a wide range.

10. In a superheterodyne receiver, an oscillator-modulator system comprising a vacuum tube having a cathode, an anode and at least three grids located in the space path between said cathode and anode, oscillation-producing feedback coupling between two of said grids causing sustained oscillatory currents to flow in said space path between said cathode and at least one of said two grids, a signal input circuit coupled between a third of said grids and said cathode, and an output circuit coupled to said anode, causing said oscillatory currents to modulate the signal from said input circuit, means for developing a bias voltage which becomes more negative when the signal intensity increases, and means for impressing said bias voltage on said third grid, thereby maintaining the output intensity in said output circuit more nearly constant than the input intensity over a considerable range of input signal intensities, and at the same time preventing any substantial variation of said oscillatory currents.

11. A modulation system comprising a vacuum tube having an input circuit and an output circuit, said vacuum tube having a space-current path in which are included a cathode and at least two grids, one of said grids having a source of alternating voltage connected thereto, the other of said grids having said input circuit connected thereto and having impressed thereon a variable bias voltage more negative than said cathode, said other grid being of the type giving a gradual variation of space current when said bias voltage is varied.

12. A modulation system comprising a vacuum tube having a cathode, an anode and first, second and third grid-like electrodes interposed in the space path, in the order named, from said cathode to said anode, a signal input circuit connected between said third electrode and said cathode, an output circuit connected between said cathode and said anode, a source of oscillations connected between said first electrode and said cathode, a source of positive voltage connected to said second electrode, and a source of variable negative bias voltage applied to said third electrode for controlling the output of said system, said third electrode being of the type which provides a very gradually changing output with varying bias voltage over a wide range of output and bias voltage.

13. A modulation system comprising a vacuum tube having a cathode, an anode and first, second, third and fourth grid-like electrodes interposed in the space path, in the order named, from said cathode to said anode, a signal input circuit connected between said third electrode and said cathode, a modulated-signal output circuit connected between said cathode and said anode, a source of positive voltage applied to each of said second and fourth electrodes, a source of oscillations connected between said first electrode and said cathode, and means for applying a variable bias voltage upon said third electrode, whereby the output of said tube may be varied over a wide range.

14. Means for performing on an electric signal wave in one vacuum-tube space path the combined operations of modulation, amplification, and bias-voltage control of amplification, said means comprising a cathode, an inner grid, an inner screen, an outer grid, an outer screen and an anode, all situated in said space path in the order named, said grids having a negative average bias relative to said cathode, said screens and anode being considerably positive relative to said cathode, said inner grid and inner screen having oscillation-producing coupling therebetween, said outer grid having a signal-voltage source coupled thereto, said anode having an output circuit coupled thereto responsive to the difference between the signal and oscillation frequencies, said amplification being controlled by the outer grid bias.

15. Means for performing on a signal in one vacuum-tube space path the combined functions of complete modulation, amplification, and gradual control of amplification, said means comprising a cathode, a sharp-cutoff inner grid, an inner screen, a gradual-cutoff outer grid, an outer screen and an anode, all situated in said space path in the order named, said grids having a negative average bias relative to said cathode, said screens and anode being considerably positive relative to said cathode, said inner grid and inner screen having oscillation-producing coupling therebetween which periodically reduces the space current to zero, said outer grid having a signal-voltage source coupled thereto, said anode having an output circuit coupled thereto responsive to the difference between the signal and oscillation frequencies, said amplification being controlled gradually by a variation of the negative bias on said outer grid.

16. A system having the means according to claim 14 in combination with means for causing the outer grid bias to increase automatically with increasing signal intensity, thereby maintaining the amplified signal voltage more nearly uniform than the signal voltage of said source.

17. A system having the means according to claim 15 in combination with means for causing the outer grid bias to increase automatically with increasing signal intensity, thereby maintaining

the amplified signal voltage more nearly uniform than the signal voltage of said source.

18. The method of modulating a signal in a vacuum tube having a cathode, an anode and a space path therebetween, which comprises attracting an electron stream to an intermediate position in said path, retarding said stream to form a virtual cathode just beyond said position, modulating the density of the virtual cathode by varying the attraction of said stream, further attracting a part of said stream from said virtual cathode to said anode, and causing said signal to vary the further attraction of said part of said stream, the modulation of the density of the virtual cathode thereby causing modulation of the signal in said vacuum tube.

19. The method of modulating a signal in, and controlling the modulated output of, a vacuum tube having an actual cathode, an anode and a space path therebetween, which comprises attracting an electron stream to an intermediate position in said path, retarding said stream to form a virtual cathode just beyond said position, producing oscillations in the space path between said actual and virtual cathodes by varying the attraction of said stream, further attracting a part of said stream from said virtual cathode to said anode as output current, causing the signal to vary the further attraction of said part of said stream and thereby to produce in the output current path a current fluctuation of the frequency difference between signal and oscillation, and controlling the current in said output path by controlling said further attraction without substantially affecting the oscillations in the space between said actual and virtual cathodes.

HAROLD A. WHEELER.

CERTIFICATE OF CORRECTION.

Patent No. 1,958,027. May 8, 1934.

HAROLD A. WHEELER.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, line 74, for "Condensed" read Condenser; page 5, line 89, for "compounds" read components; and page 6, line 10, for "out-off" read cut-off; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 19th day of June, A. D. 1934.

Bryan M. Battey

(Seal) Acting Commissioner of Patents.

Exhibit Z attached to and forming part
of Affidavit of Harold A. Wheeler
Civil Action 6677

P. 142

Sept. 24, 1935. H. A. WHEELER 2,015,327

ELECTRON DISCHARGE DEVICE

Filed Jan. 30, 1933

Fig. 1.

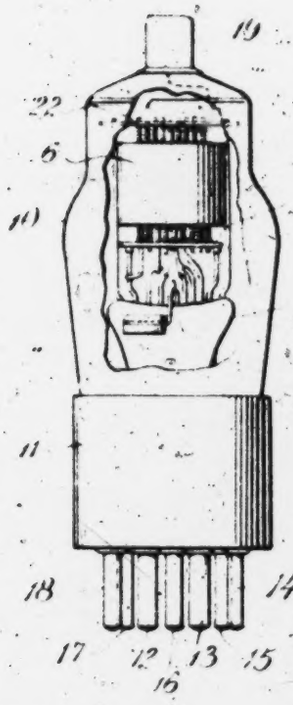


Fig. 2.

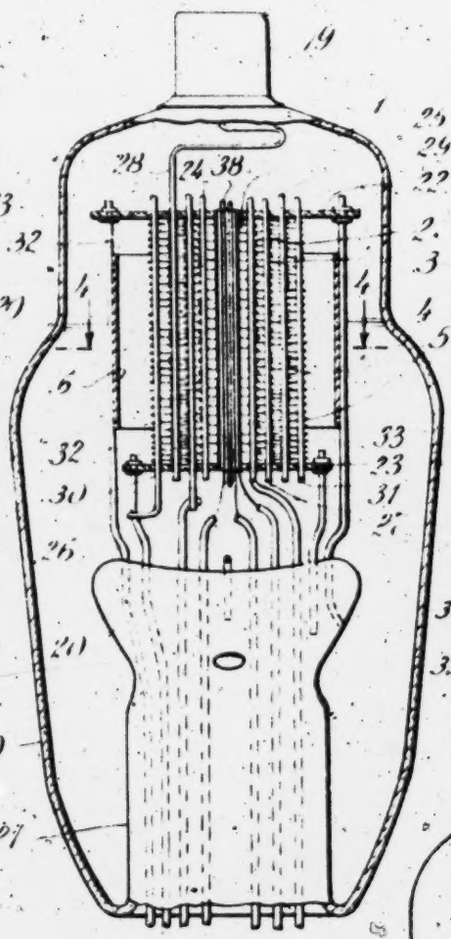


Fig. 3.

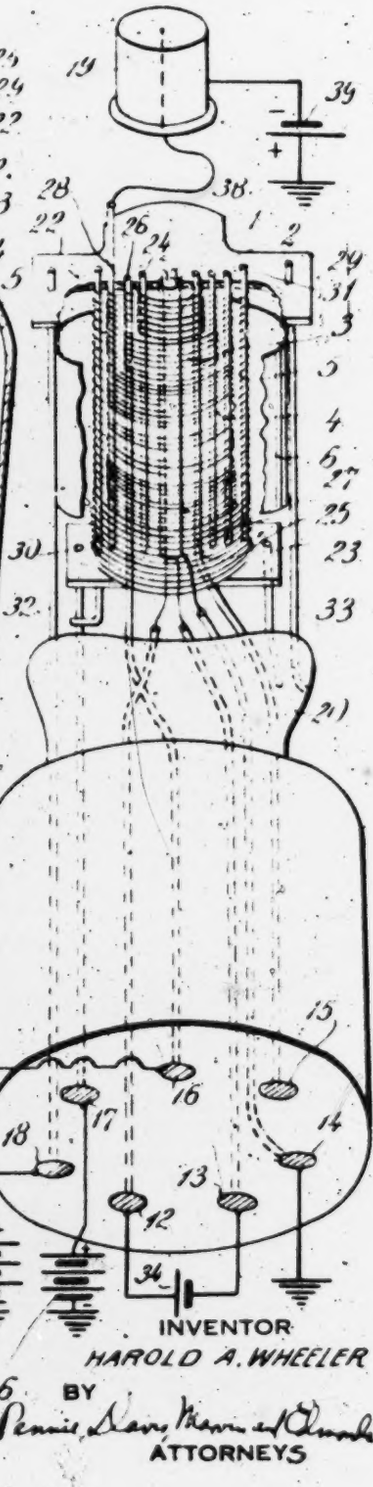


Fig. 5.

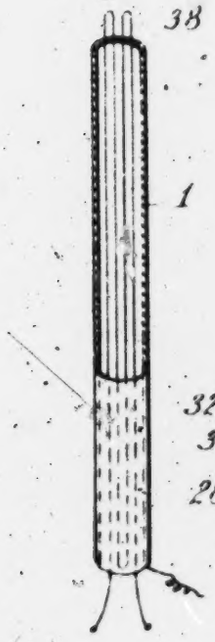
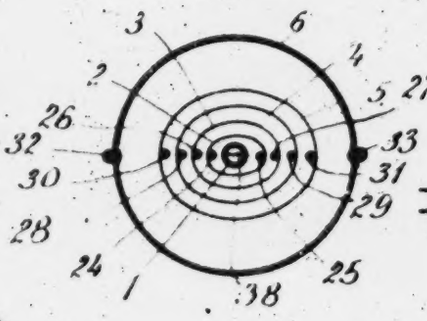


Fig. 4.



INVENTOR
HAROLD A. WHEELER

BY
Pennie, Davis, Marvin & Edmonds
ATTORNEYS

Patented Sept. 24, 1935 2,015,327

UNITED STATES PATENT OFFICE

2,015,327

ELECTRON DISCHARGE DEVICE

Harold A. Wheeler, Great Neck, N. Y., assignor to Hazeltine Corporation, a corporation of Delaware

Application January 30, 1933, Serial No. 654,327

5 Claims. (Cl. 250—27)

This invention relates to electron discharge devices, and more particularly to devices of this character having five or more electrodes.

It is an object of this invention to provide a device which is particularly well-adapted to perform the function of modulation. A related object is to provide a modulator valve which can be readily controlled by means of a grid bias voltage.

In a preferred embodiment for carrying out the above objects, there is provided a vacuum tube having six electrodes, namely, an electron-emitting cathode and a plate, or anode element, in the space path between which are located four other electrodes. These four latter electrodes are in the form of screens and grids and are located at successively increasing distances from the electron-emitting element, the first of these screens and grids being designated as closest to the said emitting element.

The term "grid" or "grid-like electrode", as used in the specification and claims, denotes an electrode by which, or through which, electrons may pass. The term "screen" denotes a form of grid-like electrode by which, or through which, electrons may pass and which ordinarily is maintained at a substantial positive potential with respect to the actual cathode.

A feature which makes the device according to this invention particularly well suited as a modulator is the construction of the grid which is the third of these screens and grids in point of distance from the cathode; this grid is formed of a mesh having a variable spacing or pitch. It is preferable that the greater portion of this third grid be of relatively fine mesh, or pitch, although a substantial portion may be of much coarser mesh.

The second of these interposed electrodes in point of distance from the cathode is a screen preferably constructed with a fine mesh or pitch.

The fourth of these interposed screens is incorporated for use as an ordinary screen-grid; and it is found that the device is operative when this fourth screen is omitted.

In the drawing:

Figure 1 illustrates an electron discharge device in accordance with this invention, a portion of the glass-enclosing vessel being cut away to show more clearly the position of the electrodes within;

Fig. 2 is a vertical sectional view of the device showing in detail its construction and the positions of the elements;

Fig. 3 is a broken diagram showing in perspective the construction of the elements and also indicating the manner of connecting operating voltages which place the device in an operative condition;

Fig. 4 is a plan view, in section, of the electrode construction; and

Fig. 5 is an enlarged illustration, partially in section, of the cathode electrode and the means for heating the same.

Referring to Figure 1, the device comprises an evacuated glass bulb 10, the stem end of which is fitted into a bakelite base 11 in which are embedded seven projecting terminal lugs, numbered 12 to 18, respectively, adapted to fit into a suitable socket. An eighth terminal 19 is situated at the top of the bulb in the form of a metallic cap cemented to the glass. The electrodes of the device are supported by a number of vertical supporting wires embedded in a glass stem 20 formed on a reentrant portion 21 at the stem end of the bulb (see Fig. 2). For the purpose of maintaining the supporting wires rigidly in their upright position, there are provided two flat guides 22 and 23 of an insulating material, such as mica, through which the supporting wires project. The upper guide 22 is constructed to snugly fit within the dome-like end of the glass bulb.

The following electrode construction is employed: A cathode 1 in the form of a sleeve of very small diameter is centrally located within the bulb. This sleeve is preferably constructed of nickel coated with strontium and barium oxides for the purpose of causing it to copiously emit electrons when heated. For the purpose of heating the cathode sleeve, there is located within the sleeve a heater filament 38 of fine wire, preferably of tungsten, coated with ceramic insulation and threaded back and forth within the sleeve in the form of a W as shown in Fig. 5. The ends of the heater filament are connected to the large-diameter terminal lugs 12 and 13 at the base.

Surrounding the cathode at a small distance therefrom is an inner grid electrode 2 in the shape of an elliptical cylinder formed by a helix of fine wire and supported on two of the vertical supporting wires 24 and 25. This grid or grid-like electrode is preferably wound with a relatively small pitch (distance between adjacent turns) which is uniform throughout. The construction of this particular grid, however, is not critical. Fig. 4, which is a plan view of the electrode construction, shows the elliptical form of grid-electrode 2 and also of the remaining electrodes about to be described. The major axis of

each ellipse is only slightly greater than the minor axis.

A second grid-like electrode 3, here called an inner screen, is constructed in the form of an elliptical cylinder by winding a helix of wire which surrounds the first grid 2, the second grid-like electrode being supported on the two supporting wires 26 and 27. This second helix is of fine mesh, that is, has a small pitch, which is preferably uniform throughout.

A third grid electrode 4, here called an outer grid, surrounds the electrode 3, and is likewise formed by a helix of wire in the shape of an elliptical cylinder supported on supporting wires 28 and 29; but the pitch or mesh of this electrode is not uniform throughout its extent. Throughout the greater portion, the pitch is very fine, but in one or more small ranges, the pitch is substantially increased. A construction of this third grid which has been found very satisfactory is one in which fifty turns of .004-inch diameter wire are wound so that the major axis is 0.360 inch and the minor axis 0.316 inch, the component turns, numbered from one end to the other, having the pitch indicated in the following table:

Turn	Pitch
1-18	.014 inch
19-20	.018
21	.025
22-23	.018
24	.042
25-26	.018
27	.050
28-29	.018
30	.034
31-32	.018
33-50	.014

Surrounding this third grid, and supported on supporting wires 30 and 31, is a fourth grid-like electrode 5, here called an outer screen, also constructed of a helix in the form of an elliptical cylinder. This fourth grid-like electrode preferably has a relatively fine mesh which is uniform throughout.

Finally, a plate 6, in the form of an elliptical cylinder, is provided which surrounds the entire grid-electrode structure, this plate being supported on supporting wires 32 and 33. The plate is preferably constructed of carbonized nickel and its axial length is not as great as that of the other electrodes.

From the foregoing description, it is observed that the first, second, third and fourth grid-like electrodes, designated 2, 3, 4 and 5, respectively, are located at succeedingly increasing distances, in the order named, from the cathode in the space path between the actual cathode and the anode.

Constructional data for the electrodes other than the third grid electrode, or outer grid 3, which have been found very satisfactory, are as follows:

Inner grid 2—major axis, 0.121 inch; minor axis, 0.96 inch; wound with 25 turns of .004 inch diameter wire with a .033 inch uniform pitch.

Inner screen 3—major axis, 0.236 inch; minor axis, 0.167 inch; wound with 33 turns of .005 inch wire with a .025 inch uniform pitch.

Outer screen 5—major axis, 0.460 inch; minor axis, 0.460 inch; wound with 33 turns of .005 inch diameter wire, with a .025 inch uniform pitch.

The connection of operating voltages which place the device in a very advantageous operative condition, particularly for use as a modulator, is illustrated in Figure 3. There is connected across terminal lugs 12 and 13 a battery 34 (or other source of filament heating current) which serves to heat a W-type filament 35 within the cathode sleeve, the said cathode itself being nominally grounded by the ground connection at terminal 14. Batteries 35, 36 and 37, or other sources of direct voltage are connected between ground and the terminals 16, 17 and 18, respectively, for applying positive voltages to the inner screen 3, the outer screen 5 and the plate 6, respectively. A negative bias battery 38 is connected between ground and the cap 19 for placing a negative bias upon the non-uniform mesh, outer grid 4.

With the above-described system of operating voltages, the action of the device is as follows: The heated cathode 1 emits electrons which are attracted to the inner screen 3 by virtue of the positive voltage applied to the latter. The electrons upon reaching the screen 3 are traveling at a high speed so that most of them pass on through the screen and approach the outer grid 4, the negative potential of which retards the electrons and causes most of them to be attracted back to the positive screen 3. This retarding action causes a cloud of slowly-moving electrons to accumulate between the electrodes 3 and 4. Hence, the position of this cloud may be termed a "virtual cathode" because of the fact that the electrons can be easily drawn away from the cloud in the same manner that they were originally drawn away from the vicinity of the actual cathode 1. Since the screen 5 and plate 6 are at a positive voltage, a stream of electrons is drawn from the "virtual cathode", through the meshes of the grid-like electrodes 4 and 5 to the plate. Electrodes 4, 5 and 6 function similarly to the respective control grid, screen and plate of screen-grid tetrode tubes. The outer screen 5 will usually have applied to it a source of positive voltage somewhat less than that of the plate in the preferred manner of screen-grid tubes.

The electron-discharge device in accordance with this invention has been found to be very useful where it is desired to exert a control upon the action of a vacuum tube without actually introducing into a circuit or space path of that tube external elements which would not very successfully cooperate. For example, the repeating portion of the tube may be considered to have input terminals which are the outer grid 4 and the virtual cathode, and to have output terminals which are the plate 6 and the virtual cathode. Since the potential of the virtual cathode is the same as that of the actual cathode, it is found that input signals impressed between terminals 14 and 19 will be repeated at the output between terminals 18 and 14.

The desired modification of the input signals can then be effected by applying the modifying voltage to the inner grid 2, that is, between terminals 14 and 15. This modifying voltage may often be a simple alternating voltage, which then causes the entire device to operate as a modulator. The effect of the voltage on the grid 2 is to modify the electron stream which flows to the virtual cathode and hence indirectly to modify the space current between the virtual cathode and the plate.

Since the electrodes 4, 5 and 6 exert very little effect on the space current to electrodes 2 and 3, the inner and outer control grids 2 and 4 may be operated quite independently of each other. For

example, it is quite possible and convenient to vary the negative bias applied to the outer control electrode 4; and this may be easily accomplished without affecting the action of any modifying voltage applied to inner grid 2. This variation of the negative bias of the outer grid 4 is a very convenient expedient inasmuch as it permits a very simple control of the responsiveness of the device.

The non-uniform size of the meshes of control grid 4, commonly known as the variable-mu or gradual-cutoff type of grid, permits a wide range of bias voltage to be applied without causing signal distortion and without interfering with the normal action of electrodes 2 and 3.

The outer screen 5 may be omitted, but its presence greatly improves the results, particularly in obtaining the greatest responsiveness. This screen, in general, performs the function of a similar screen in the well-known screen-grid tetrode, and is therefore usually given a positive voltage somewhat less than that of the plate.

It is usually desirable to carbonize the inner wall of the glass bulb or vessel, as indicated in Figure 1 by the dotted portion of the glass; this, however, is a refinement which may be omitted.

I claim:

1. An electron discharge device adapted to function as a bias controlled signal translating device comprising a closed evacuated vessel containing a centrally located cathode, at least three substantially concentric cylindrical grid-like electrodes surrounding said cathode and being of succeedingly increasing diameters, and a cylindrical plate surrounding said electrodes, the third from the cathode of said electrodes having non-uniform grid spacings and having impressed thereupon a negative potential, and the second from the cathode of said electrodes having impressed thereupon a positive potential, whereby electrons drawn from said cathode form, in effect, a virtual cathode between said second and third electrodes, the non-uniform grid spacings of said third electrode serving to permit a wide range of bias voltage to be applied thereto without causing signal distortion and without interfering with the normal action of the innermost two grid-like electrodes.

2. An electron discharge device adapted to function as a bias controlled signal translating device comprising a closed evacuated vessel containing a centrally located cathode, four substantially concentric cylindrical grid-like electrodes surrounding said cathode and of succeedingly increasing diameters, and a cylindrical anode surrounding the said electrodes, the third from the cathode of said grid-like electrodes having a grid spacing which is non-uniform and having impressed thereupon a negative potential, and the second from the cathode of said grid-like electrodes having impressed thereupon a positive potential, whereby electrons drawn from said cathode form, in effect, a virtual cathode between said second and third electrodes, and a positive potential being applied to the fourth electrode from the cathode and to said anode, whereby electrons are drawn to said anode from said virtual cathode, the non-uniform grid spacings of said third electrode serving to permit a wide range of bias voltage to be applied thereto without causing signal distortion and without interfering with the normal action of the two grid-like electrodes nearest the cathode.

3. An electron discharge device according to claim 2 in which the grid spacing of each of said electrodes, except said third electrode, is uniform.

4. An electron discharge device adapted to function as a bias controlled signal translating device, comprising a closed vessel containing a cathode, at least three grid-like electrodes near said cathode and located at succeedingly increasing distances from said cathode, and a plate substantially surrounding said cathode and said electrodes, the third from the cathode of said electrodes having non-uniform grid spacings and having impressed thereupon a negative potential, and the second from the cathode of said electrodes having impressed thereupon a positive potential, whereby electrons drawn from said cathode form, in effect, a virtual cathode between said second and third electrodes, the non-uniform grid spacings of said third electrode serving to permit a wide range of bias voltage to be applied thereto without causing signal distortion and without interfering with the normal action of the innermost two grid-like electrodes.

5. An electron discharge device adapted to function as a bias controlled signal translating device comprising a closed evacuated vessel containing a cathode, four grid-like electrodes near said cathode and located at succeedingly increasing distances from said cathode, and an anode substantially surrounding said cathode and said electrodes, the third from the cathode of said grid-like electrodes having a grid spacing which is non-uniform and having impressed thereupon a negative potential, and the second from the cathode of said grid-like electrodes having impressed thereupon a positive potential, whereby electrons drawn from said cathode form, in effect, a virtual cathode between said second and third electrodes, and a positive potential applied to the fourth from the cathode of said grid-like electrodes and to said anode, whereby electrons are drawn to said anode from said virtual cathode, the non-uniform grid spacings of said third electrode serving to permit a wide range of bias voltage to be applied thereto without causing signal distortion and without interfering with the normal action of the two grid-like electrodes nearest the cathode.

HAROLD A. WHEELER.

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PEAK DETECTOR

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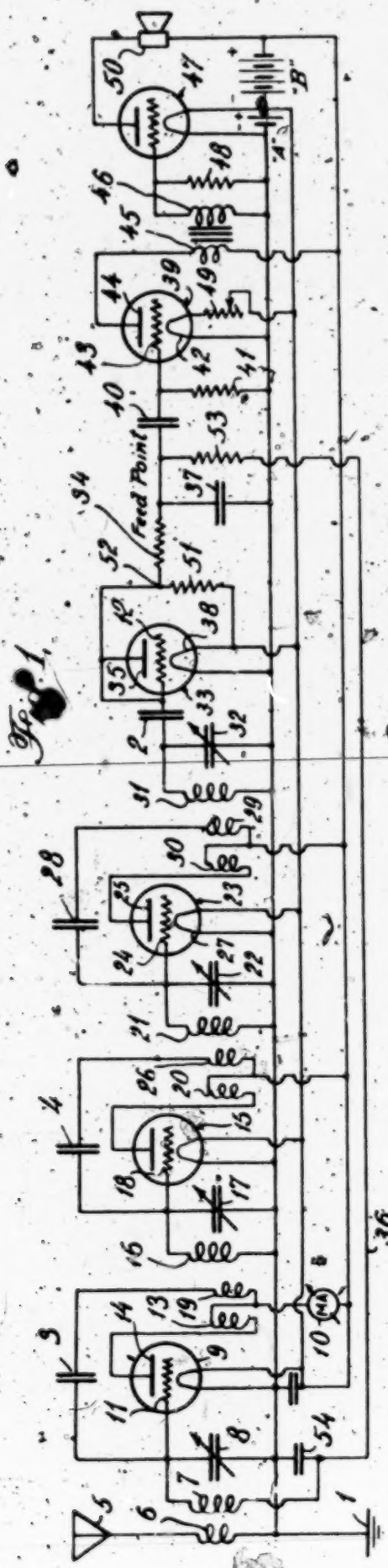

Fig. 1.

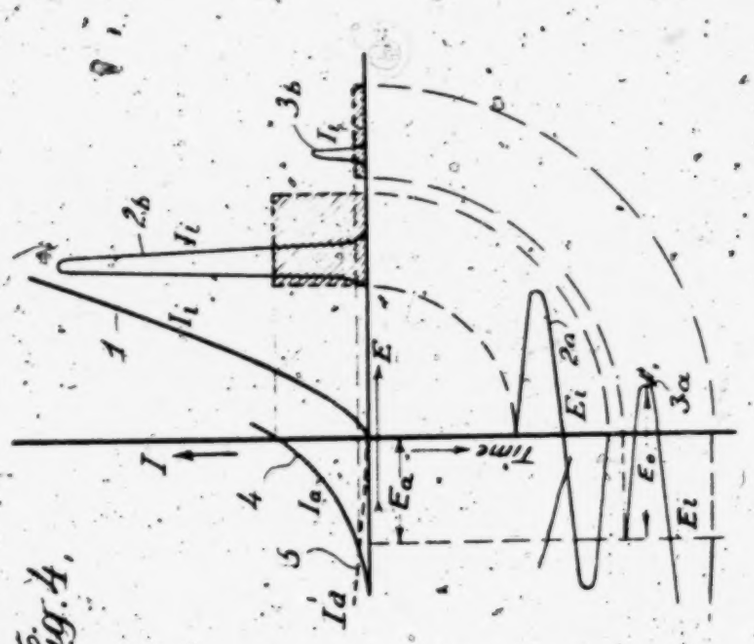

Fig. 4.

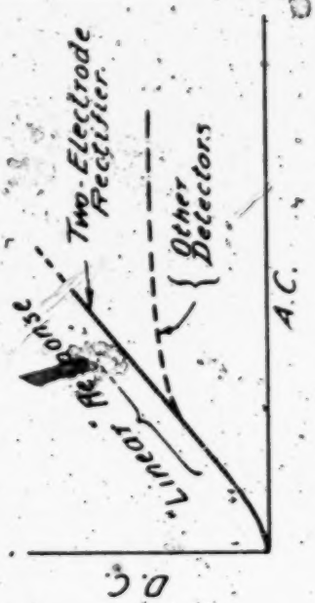

Fig. 2.

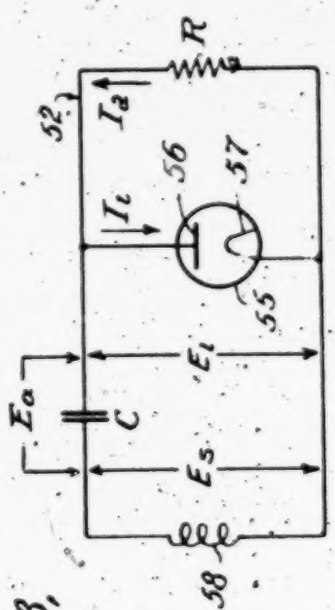

Fig. 3.

INVENTOR
HAROLD A WHEELER
BY
Pennie, Davis, Marvin and Edmonds
ATTORNEYS

March 20, 1934. H. A. WHEELER 1,951,685

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Fig. 5,

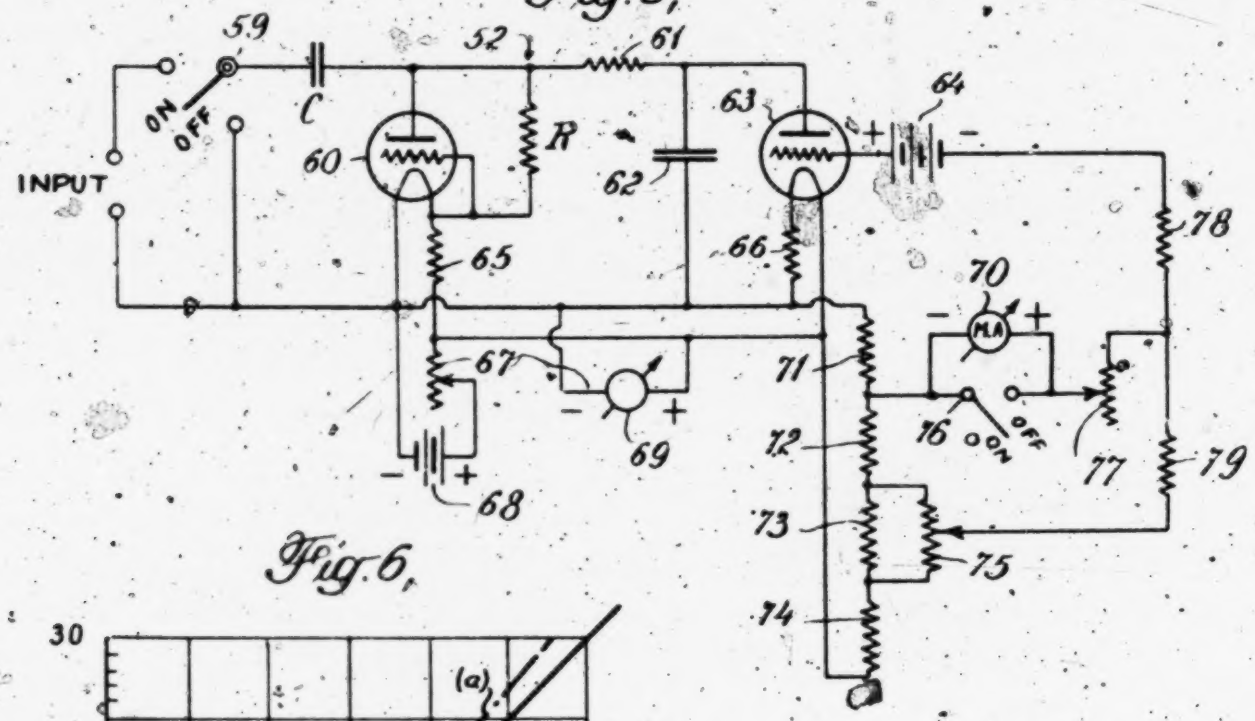


Fig. 6,

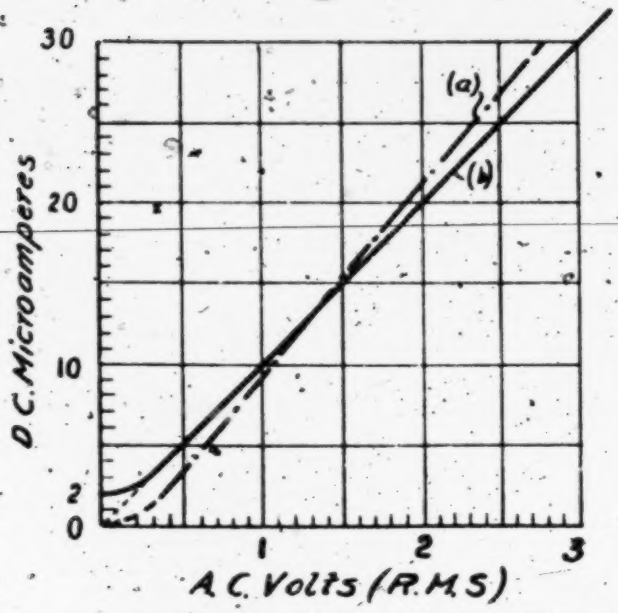
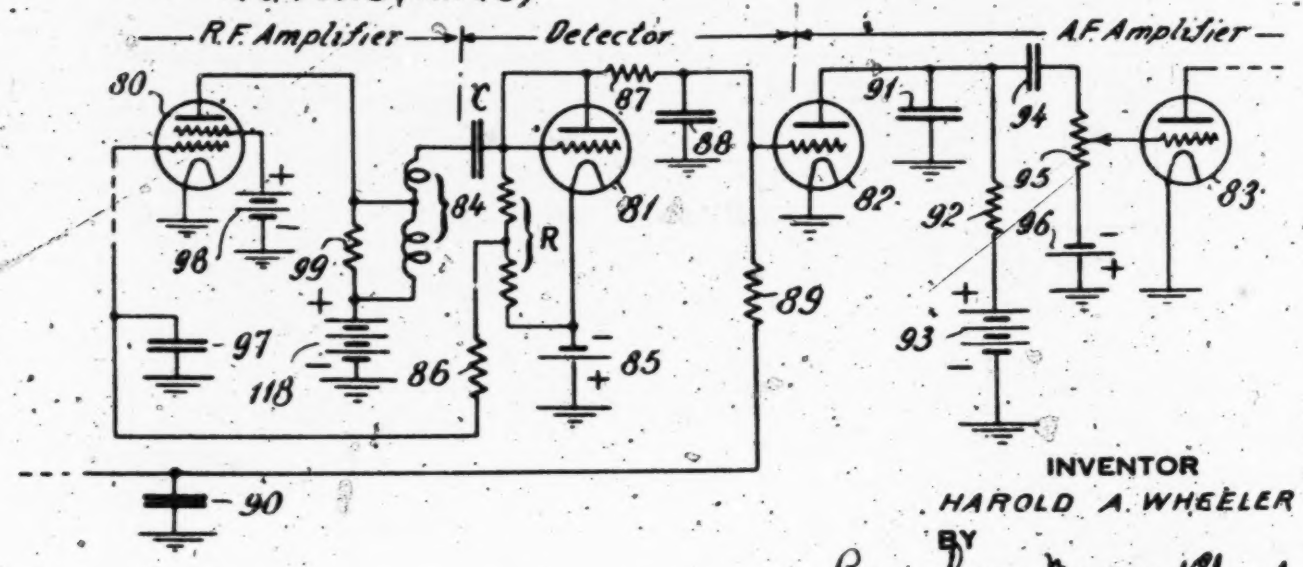


Fig. 7,



INVENTOR
HAROLD A. WHEELER
BY
Pennie, Davis, Marvin & Edmonds
ATTORNEYS

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March 20, 1934. H. A. WHEELER 1,951,685

PEAK DETECTOR

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Fig. 8,

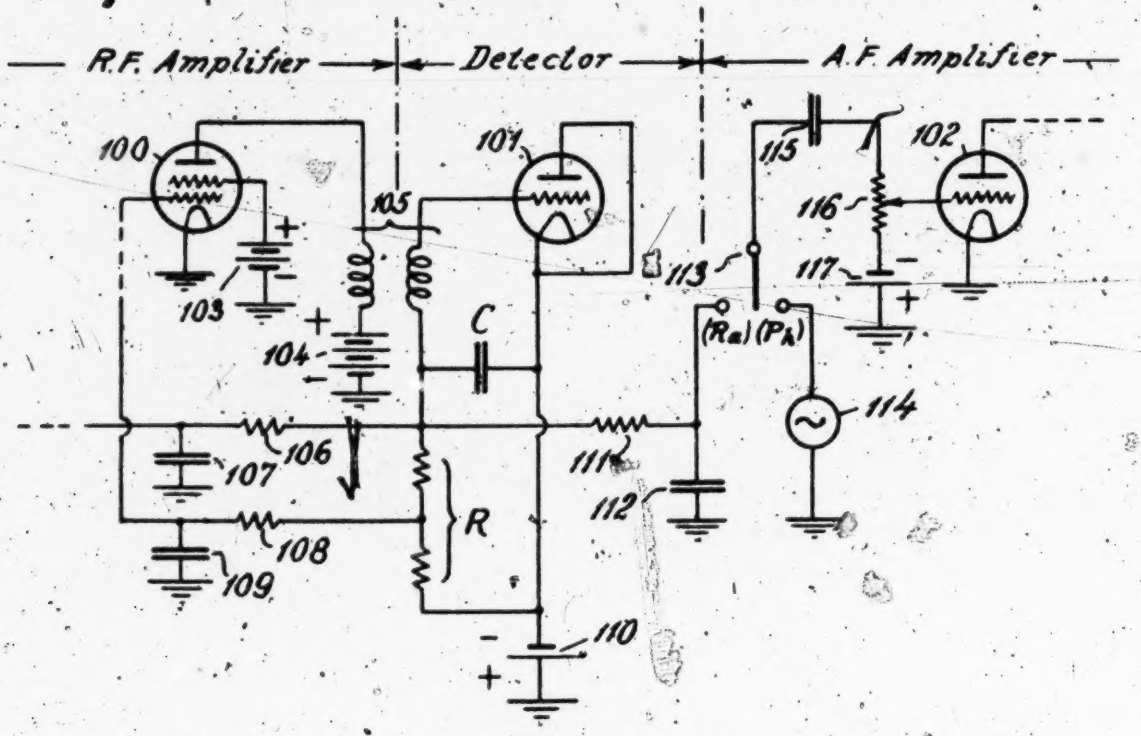
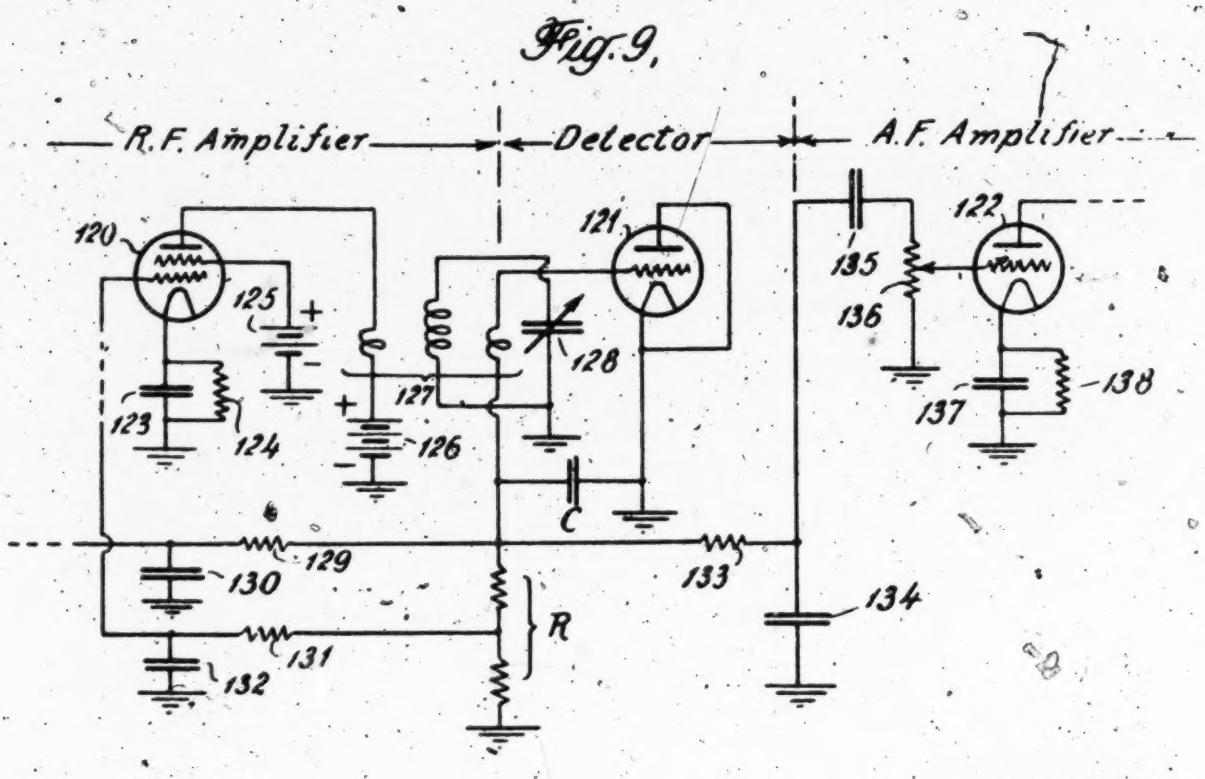


Fig. 9,



INVENTOR
HAROLD A. WHEELER

BY
Pennie, Davis, Marvin & Edmonds
ATTORNEYS

March 20, 1934. H. A. WHEELER 1,951,685

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Fig. 10a,

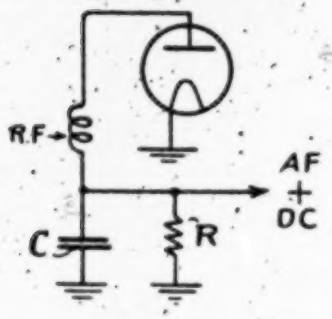


Fig. 10b,

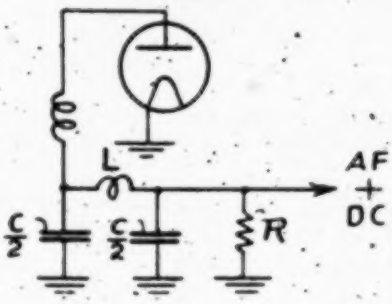


Fig. 10c,

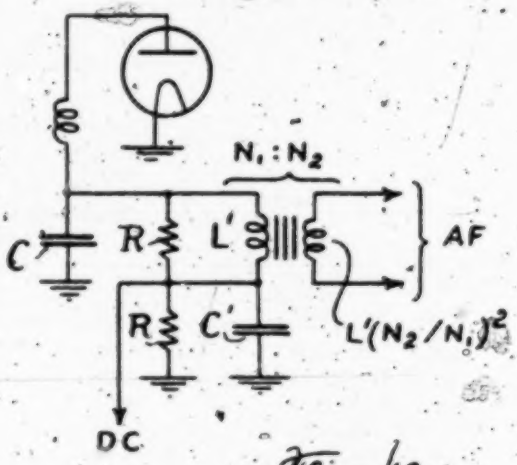


Fig. 10d,

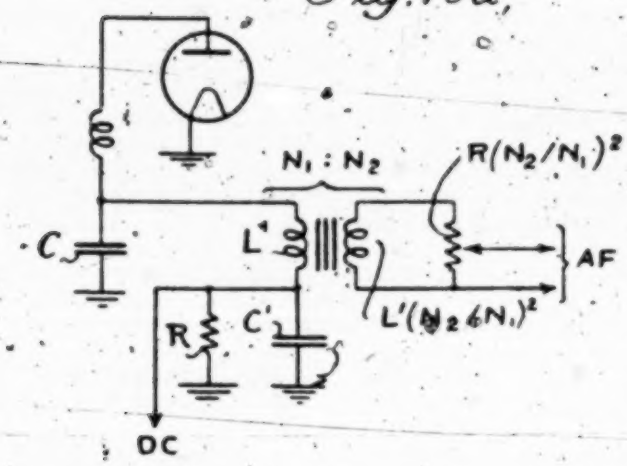


Fig. 10e,

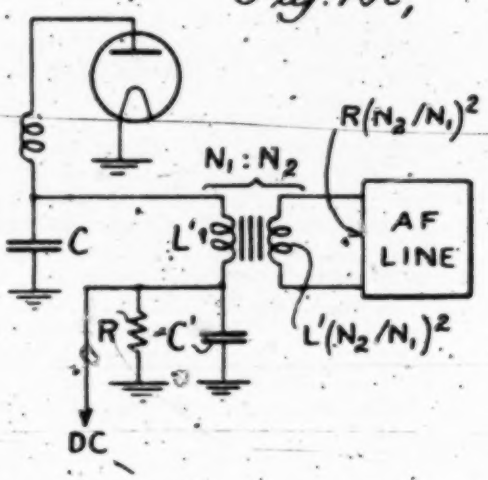


Fig. 10f,

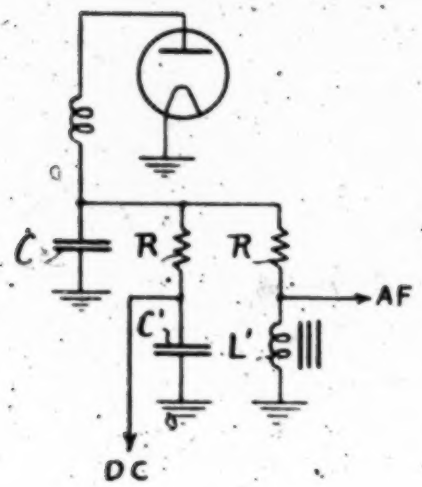


Fig. 10g,

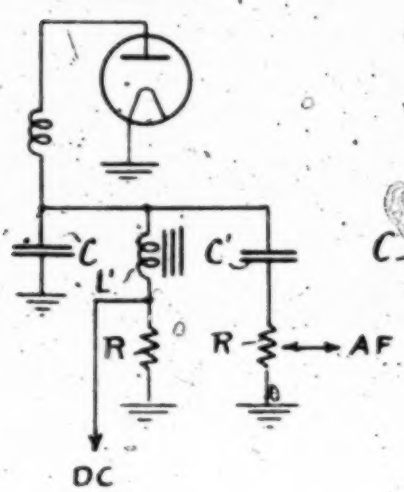
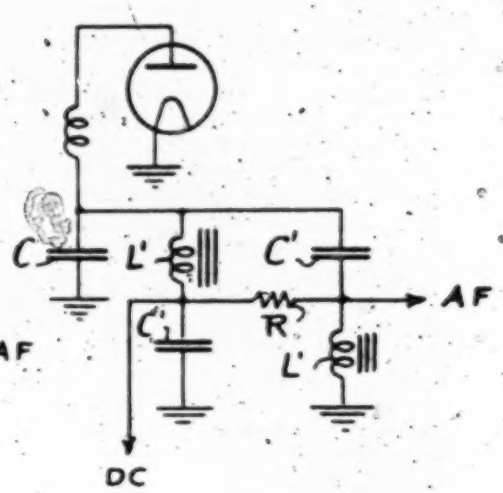


Fig. 10h,



INVENTOR
HAROLD A. WHEELER
BY
Pierce, Scheffler, Mitchell & Edwards
ATTORNEYS

Patented Mar. 20, 1934 1,951,685

UNITED STATES PATENT OFFICE

1,951,685

PEAK DETECTOR

Harold A. Wheeler, Great Neck, N. Y., assignor to Hazeltine Corporation, a corporation of Delaware

Application April 1, 1931, Serial No. 526,857
In Great Britain July 3, 1928

8 Claims. (Cl. 250—27)

This invention relates to signal detection and more particularly to rectifying or detecting arrangements adapted to rectify radio or carrier wave signals.

This application is a continuation in part of my copending application Serial No. 203,879, filed July 7th, 1927.

The detectors contemplated herein are of a type in which the rectified response is directly proportional to the amplitude of the applied carrier wave.

In its broadest aspect, the invention comprises a rectifying element having in series therewith a capacity across which a modulation or audio-frequency component is developed, and having in shunt therewith a high impedance through which the direct current component of the rectified response flows.

A feature of the operation of detectors of the type of this invention is that the rectifying action is effected by the peaks of the signal waves; hence they will be referred to as "peak" detectors.

Advantages derived from the use of such detecting devices are:

(1) The substantially direct proportionality or "linear" relation, between the signal voltage and the direct current component of the rectified voltage or current;

(2) The undistorted reproduction in the rectified output of the envelope of a modulated carrier signal input;

(3) The absence of undesirable overload limitations;

(4) The simplicity of operation, requiring no polarizing voltages; and

(5) Improved circuit arrangements by means of which the detector is made to respond alike to rapidly and slowly modulated carrier waves.

Detecting devices characterized by the above noted advantages are particularly well-adapted for detecting the signals at the output of a carrier-frequency amplifier which is provided with an automatic amplification regulating arrangement for maintaining substantially constant signal strength at the amplifier output. Such a combination of a carrier-frequency amplifier, a "linear" type detector and an automatic volume controlling arrangement is described in my said copending original application Serial No. 203,879, and is claimed in my United States Letters Patent No. 1,879,863 which is a division of my said application Serial No. 203,879.

By virtue of the use of a linear type detector, the carrier wave can be maintained at a substantially constant level at the output of the amplifier, and the modulation or audio-frequency component of the rectified response has the same wave form as the modulation component of the applied carrier signal.

While some of the present improvements are applicable to detectors having three or more electrodes, the invention will be described with reference to the diode detector, which has the merit of simplicity.

An important application of the invention is a vacuum tube voltmeter which comprises a "peak" detector, a direct current amplifier and a current responsive indicator which may be calibrated to measure directly the voltage applied to the voltmeter. This arrangement will be hereinafter described in detail.

An important feature of the invention is a filtering system associated with the rectifier and so arranged that the direct current component and modulation current component of the rectified response may be separated, while at the same time, the load impedance applied to the rectifier is substantially the same for both of said rectified components.

Another feature of the invention is the use as a diode of a vacuum tube having more than two electrodes. In one of these arrangements a pair of inner electrodes are utilized as the electrodes of the diode and an outer electrode is used as a shield between the inner electrodes and the surrounding space.

Fig. 1 is a circuit diagram of a complete radio receiver which includes parts of the present invention, and comprises a three-stage radio-frequency amplifier followed by a rectifier, a two-stage audio-frequency amplifier, and a loud speaker or other suitable indicating device;

Fig. 2 shows graphically a comparison between the performance of the two-electrode valve or rectifier, and that of the ordinary three-electrode detector;

Fig. 3 is a fragmentary diagram of the detector of Fig. 1.

Fig. 4 shows graphically the behavior of the diode detector of the type of this invention;

Fig. 5 is a circuit diagram of a vacuum-tube voltmeter comprising a diode detector and a direct current amplifier;

Fig. 6 shows the calibration curves of the voltmeter of Fig. 5;

Fig. 7 is a partial circuit diagram of a radio receiver having a diode detector which receives the output of an auto-transformer-coupled untuned radio-frequency amplifier stage;

Fig. 8 is a partial circuit diagram of a radio

receiver having a diode detector which receives the output of a transformer-coupled untuned radio-frequency amplifier stage;

Fig. 9 is a partial circuit diagram of a radio receiver having a diode detector receiving the output of a tuned radio-frequency amplifier stage; and

Figs. 10a to 10h are fragmentary diagrams of detectors showing various types of output networks which are equivalent to a pure resistance load insofar as audio-frequency and direct current reactions are concerned.

It may be here noted that throughout the present specification and claims the terms "rectifier" and "detector" are, in general, used interchangeably, the terms "rectifying" and "converting" being employed in the general sense to include the process of changing alternating current into a form of direct current or pulsating unidirectional current. No distinction is made between batteries and other power supply devices, which, it it well understood, can be used with substantially identical results. It is also well known that vacuum-tube cathodes may be directly heated filaments or indirectly heated cathodes, with similar results.

Referring in detail to Fig. 1, there is shown an antenna 5 connected to ground 1 through the primary winding 6 of a radio-frequency transformer, the secondary winding 7 of which, tuned by a variable condenser 8, is connected at one point to the filament of the vacuum tube 9 in the first radio-frequency amplifying stage and at another point to the grid 11 of this vacuum tube. The output circuit of this vacuum tube extends from the filament system, through a high-voltage battery "B", a milliammeter 10, primary winding 13 of a second radio-frequency transformer to the anode or plate 14 of this vacuum tube. In order to neutralize the inherent capacity between the grid 11 and the plate 14, and thereby to prevent oscillations, a neutralizing winding 19, electromagnetically coupled to winding 13, and neutralizing condenser 3 are employed in the manner described in the U. S. patents to Hazeltine, Nos. 1,489,228 and 1,533,858.

A second stage of radio-frequency amplification including the vacuum tube 15 neutralized by cooperation of coil 26 and condenser 4, like the first stage, comprises the secondary winding 16 of the last-mentioned radio-frequency transformer tuned by a variable condenser 17 connected between the filament system of the vacuum tube 15 and the grid 18 thereof. The output circuit of this vacuum tube also includes the high-voltage battery B and a primary winding 20 of a second radio-frequency transformer, while the secondary winding 21 of this transformer tuned by a variable condenser 22 is included in the input circuit of a third stage of radio-frequency amplification which includes vacuum tube 23. The inherent capacity effective between the electrodes 24 and 25 is neutralized by a network including the neutralizing condenser 28 and the neutralizing winding 29 as described in the mentioned patents. The output circuit of the vacuum tube 23 includes the primary winding 30 of a third radio-frequency transformer and the high-voltage battery B. The secondary winding 31 of this last mentioned transformer, tuned by a variable condenser 32, is connected in the input circuit of a rectifier 33 which input circuit includes the fixed condenser 2. The rectifier employed may be of the type commonly known in the art as a two-electrode "Fleming" valve, or may consist of an equivalent such as a three-electrode vacuum tube, as shown, having its grid 12 and its plate or anode 35 directly connected together to comprise in effect a single anode.

The three-stage amplifier functions in a manner well-known in the art to amplify the incoming signal intercepted on the antenna 5. The output circuit of the rectifier 33 includes what may be termed a "rejector" circuit for stopping radio-frequency currents which have passed through the rectifier, and consists of a network including a resistance 34 and a bypass condenser 37, connected between the anode 25 and the filament 38 of the rectifier. The output circuit of the rectifier is coupled to the input circuit of an audio-frequency amplifying vacuum tube 39 through an audio-frequency-pass filter including a fixed condenser 40 and an impedance 41 connected between the filament 42 and the grid 43 of this vacuum tube. The output circuit of this amplifier is connected between the filament 42 and plate 44 through the high-voltage battery B and the primary winding 45 of an audio-frequency transformer the secondary winding 46 of which is connected in the input circuit of a second audio-frequency tube 47, while a resistance 48 connected across the winding 46 serves to give the audio amplifier substantially uniform amplification over the desired frequency range. Instead of employing resistance 48, a closed copper band of suitable size may be placed around the transformer winding so as to be electromagnetically coupled thereto. A loud speaker or other reproducing device 50, or if required, a coupling device for a telephone system, is connected in the output circuit of the last audio-frequency amplifying tube 47. It is presumed that adequate precautions against undesired electromagnetic coupling between the various radio-frequency coupling transformers are included in all of the arrangements herein disclosed.

In accordance with one of the main features of my said copending application Serial No. 203,879, means are provided to control automatically the degree of amplification effected in the radio-frequency amplifying stages. These means include a resistance 51, connected between the filament 38 and the anode 35 of the rectifier, through which the pulsating rectified or converted current flows, thereby developing a negative voltage at terminal 52 with respect to the cathode 38. This negative voltage is applied over conductor 36 through the impedance 53 and the secondary winding 7 of the first radio-frequency transformer to grid 11 of the first radio-frequency stage. Impedance 53, together with blocking condenser 54, is effective to filter out and reject any audio-frequency currents which otherwise might be present in the conductor 36.

To complete the description of the system illustrated in Fig. 1 certain design data or constants are given herewith. It should be understood, however, that these, as well as all other constants appearing in the present specification, are mentioned merely by way of example in describing certain specific embodiments which in practice have proved eminently satisfactory, and are not intended to suggest any specific limitations as to the scope of this invention. Accordingly, fixed condenser 2 may be of 0.0005 microfarads; 37 of 0.0001 microfarads; 54 of 0.01 microfarads; 40 of 0.005 microfarads; resistance 51 of 1 megohm; 34 of 1 megohm; and 41 and 53 of 2 megohms each.

In the operation of the receiver shown in Fig.

1, a signal intercepted on the antenna 5 is successively amplified through the neutralized radio-frequency stages indicated by the vacuum tubes 9, 15 and 23. This amplified signal voltage is then rectified by the rectifier 33, and the rectified pulsating current is successively amplified by the audio amplifying stages including vacuum tubes 39 and 47, after which it may be reproduced as sound by the loud speaker 50. When the rectified or converted signal current flowing through the resistance 51 is greater than a predetermined value, there is developed at the terminal 52 sufficient negative biasing voltage which in turn is impressed, through the conductor 36, upon the grid 11 of the vacuum tube 9, to reduce the amplification of this tube. It will be apparent that as the magnitude of the rectified current flowing through resistance 51 decreases, the voltage at terminal 52 becomes less negative, and the negative biasing voltage impressed upon the grid 11 also diminishes so that the vacuum tube 9 effects an increased degree of amplification. In this manner, the radio-frequency voltage applied to the input of the rectifier is maintained at a nearly constant predetermined value, and the volume of the reproduced signal is substantially uniform under all conditions. The degree of volume of the reproduced signal is then determined by adjustment of rheostat 49 which controls the heating current in the filament 42 of the first audio-frequency amplifying tube 39. The neutralization of the grid-plate capacity of the radio-frequency amplifying tubes is particularly valuable in that it allows an increase in the effectiveness of the amplification control, because such neutralization prevents radio-frequency energy from passing through the grid-plate capacity of the tubes. Thus the relay action of the tubes is almost entirely subject to the control by grid bias voltage.

The time required for operation of the control system would ordinarily be determined by the lowest audio-frequency modulation which must be reproduced. Fading, for example, might be considered a form of modulation; the frequency of the rise and fall of signals due to fading being the frequency of modulation. If this frequency of modulation be increased sufficiently, the effect will be audio-frequency modulation. It will thus be seen that if the automatic control attained by the present invention be allowed to respond too quickly, it will tend to smooth out the desired modulation of the signals at the lower audio-frequencies. Hence, a time constant of operation is chosen which will be greater than the period of the audio-frequencies which the system is intended to amplify. This time constant of the control circuit is equal to the product of the series resistance and the shunt capacitance of the grid bias circuit, represented in Fig. 1 by resistance 53 and capacitance 54. However, since the time constant can always be reduced to a value equal to the period of the lowest modulation frequency, it may readily be set to meet the requirements of nearly any special case which may arise. For example, a value of two million ohms resistance and of 0.1 microfarad capacitance gives a time constant of one-fifth of a second, which does not appreciably affect the modulation at frequencies above five cycles. While this constant is less than required from the point of view of satisfactory audio-frequency quality in the reproduction of music, there appears to be no need for more rapid control under the conditions usually encountered. The use in this connection of condensers of large capacitance, such as one-tenth microfarad, likewise introduces another convenience in that the condensers may also serve to by-pass radio-frequencies in order to prevent undesired coupling between the detector circuit and the first radio-frequency amplifying tube because of some impedance common to those two portions of the apparatus.

There are advantages attending the use, in connection with the invention of my said copending application, of the two-electrode rectifier circuit typified by Fig. 1, which may not be apparent from the foregoing discussion. It is impossible to overload this type of rectifier, and the rectified output voltage is directly proportional to the applied alternating signal voltage when this voltage is large, say over two volts. The control system in the circuits of the figures referred to requires a large operating voltage, say ten volts, so that the latter condition of large signal voltage is realized. No such simple relationship is possible in a three-electrode detector whose rectified output never exceeds a limiting upper value, and is never proportional to the applied voltage, except over a very small range of voltages. This distinction will be seen from Fig. 2, where the abscissæ "A. C." represent the alternating signal voltages, and the ordinates "D. C." represent the rectified output voltages. It is well known that the linear curve is much more desirable when minimum distortion of a modulated signal is desired, and it will be observed from Fig. 2 that the preferred type of curve is obtained from the two-electrode rectifier.

The three-electrode detector is useful for relatively small applied voltages, and the rectified output voltage is then approximately proportional to the square of the applied voltage, i. e., to the power associated with the applied voltage. For this reason the rectified voltage increases with the carrier wave modulation. When such a detector is used in the control system, the total power from the radio-frequency amplifier is maintained at a substantially constant level, the amplitude of the carrier wave being decreased in the presence of modulation. It is desirable to maintain the carrier wave at a constant amplitude at the output of the amplifier, and this is accomplished by the two electrode rectifier as shown in Fig. 1. The control system maintains constant the average signal amplitude which is equal to the carrier wave amplitude and independent of the degree of modulation.

It will be observed that in a system employing a two-electrode rectifier such as represented by valve 33 of Fig. 1, the control bias voltage is independent of the B battery voltage.

In the foregoing description, a tuned radio receiver of the neutralized type has been used as an example. It should be pointed out, however, that the present invention may be employed with equal effectiveness in any radio receivers or carrier-current devices in wire-transmission or space-transmission systems. It has been found especially applicable to receivers of the superheterodyne type.

The behavior of the diode detector of Fig. 1 will now be explained in more detail, with reference to Figs. 3 and 4. In Fig. 3, the diode detector 55 comprises an anode 56 and cathode 57. The signal voltage E_s is supplied from the terminals of coil 58, and is applied to the detector through condenser C. This condenser may be called a "blocking condenser" because it prevents any electric charge on the anode 56 discharging

through any other path except the high resistance leakage path R. Condenser C has a value such that its impedance to carrier frequency currents is much smaller than that of the tube 55 with R in parallel; but also such that its impedance to modulation-frequency currents is much larger than that of tube 55 with R in parallel. The former condition allows E_s to be applied to the detector terminals without loss; the latter condition allows a rectified voltage E_a across condenser C to fluctuate in accordance with modulation of the signal.

Curve (1) of Fig. 4 shows the relation between instantaneous current I_i and instantaneous voltage E_i at the detector terminals. The curve shown is a 3/2-power curve, which is the theoretical relation of the vacuum tube. This relation is most closely attained in tubes having a unipotential cathode heated by indirect means, but the particular shape of this curve does not materially affect the results described herein. It is only necessary that the detector have practically uni-lateral conductivity.

The following theoretical discussion will serve to establish more definitely the mode of operation of the detector in the presence of a modulated carrier signal.

When there is no signal voltage E_s, the anode voltage E_i is held at or near that of the cathode by the leakage path R. Consider a sine-wave signal applied to the detector, of the form

$$E_s = E_o \sin \omega t$$

where E_o represents the maximum voltage of the wave; ω is 2π times the frequency of the signal wave; and t represents time.

The first cycle produces a voltage swing E_i shown by curve (2a). During the positive half of the cycle, the current I_i reaches a high value as shown by curve (2b). The condenser C is thereby charged negatively at an average rate indicated by the shaded area under curve (2b). This shaded area is equal to the area within curve (2b). As the condenser receives an increasing negative charge, the condenser bias voltage E_a grows in magnitude, and the positive swing of E_i is decreased both in amplitude and duration, as indicated by curve (3a). The charging rate is thereby rapidly decreased, as indicated by curve (3b). The current curves (2b) and (3b) are drawn on a time base as indicated by the broken line arcs extending from the corresponding voltage waves. The relation between the bias voltage E_a and the average rate of charge I_a is shown by curve (4). The charging rate I_a in curve (4) obviously approaches zero as the bias voltage E_a approaches the signal peak voltage E_o, because then there would be no positive swing of the anode voltage E_i.

During this process, the average rate of discharge I_d through R, is steadily increased as indicated by curve (5) and the equation

$$I_d = E_a/R$$

When the charging rate I_a reaches equality with the discharging rate I_d, the voltage on condenser C is increased no further. This final value of E_a is indicated by the intersection of curves (4) and (5).

It is to be noted that the final value of E_a is nearly as great as the signal peak voltage E_o. This results from the high value of R and the resulting small slope of curve (5) in Fig. 4. Greater values of R cause E_a to approach E_o more closely, but other factors make it necessary to keep the value of R within a reasonable upper limit. One of these factors is the requirement, stated above that the impedance of condenser C to modulation frequency currents must be much greater than that of the tube with R in parallel.

It is apparent that Fig. 4 illustrates the determination of the rectified voltage E_a for only one value of signal peak voltage E_o. A similar determination can be made either graphically or experimentally for various signal voltages, and the rectified direct current output plotted against the alternating current signal as in Fig. 2. This determination has been made both graphically and experimentally for a number of different practical cases, and the results can be summarized as follows: When the signal voltage is relatively large, the rectified voltage E_a is only slightly less than the signal peak voltage E_o, as in the example of Fig. 4. This near-proportionality between the rectified output and the signal, is a linear relationship, and this is a kind of "linear detection". This mode of operation may also be called "peak detection", in order to distinguish from other types of linear detection. Peak detection, it is noted, does not require a linear curve of instantaneous current and voltage, since curve (1) of Fig. 4 is not linear, but is a 3/2-power. The requirements for peak detection are quite different, as will be outlined below in more detail.

The first prerequisite of peak detection is a rectifier whose conductance in one direction is very much smaller than that in the other direction. This is very well satisfied by the diode vacuum tube, whose conductance in the reverse direction is zero, except for capacity currents. This is shown by curve (1) in Fig. 4.

The second prerequisite of peak detection is a leakage path or load whose conductance is very much smaller than that of the rectifier in the direction of greater conductance. This is shown by curve (5) as compared with curve (1) in Fig. 4. The extent to which this relationship is satisfied determines the degree to which the rectified voltage E_a approaches the peak voltage E_o. It is apparent that, in the limiting case of zero leakage current, curve (5) would coincide with the horizontal axis and E_a would equal E_o. It is also apparent that condenser C must be made sufficiently small to prevent additional audio frequency currents through this condenser, if the detector is to follow the envelope of a signal modulated at audio frequencies.

The third prerequisite of linear detection is a signal voltage sufficiently great to extend beyond the transition region of the rectifier curve (1), which is a small region (at the origin of Fig. 4) where the rectifier conductance is not sufficiently different in the two directions. Since Fig. 4 is intended to illustrate the behavior with high signal voltages, this transition region is drawn so small as not to be apparent. Its importance depends not only on the type of rectifier, but also on the magnitude of the leakage of load conductance.

The transition region is very small and relatively unimportant in the case of diodes having indirectly heated equipotential cathodes, but is somewhat greater in the case of diodes having filament cathodes directly heated by direct current.

The following rule, which has been derived on logical assumptions, expresses approximately the minimum value of peak signal voltage required

in most cases to extend beyond the transition region of curve (1):

$$E_o = \frac{2\left(\frac{dI_i}{dE_i} + \frac{I}{R}\right)}{\frac{d^2I_i}{dE_i^2}}$$

The first and second derivatives in the equation are those of curve (1) at its intersection with curve (5). (This intersection need not occur exactly at the origin, and frequently does not in practical cases.) The term 1/R is, of course, the conductance of the leakage path or load. This value of E_o is smaller when R is increased or when the curvature term (denominator) is increased. It is not within the scope of this application to describe the derivation of this rule.

The initial value of signal voltage required to give substantially linear detection in practical circuits ranges from 0.1 to 1 volt, and may be obtained from the above rule or by experiment. In the case of a modulated carrier, the carrier voltage must be much greater than this initial voltage because the signal voltage is at times much smaller than the average or carrier voltage. For example, the value of 2 volts mentioned above was the computed carrier voltage required to give a signal always greater than 0.5 volt when modulated up to 75%.

When the above prerequisites of peak detection are met in practice, as in the automatic volume control receiver of Fig. 1, the performance of the detector is ideal. The rectified voltage closely follows the modulation envelope of the signal voltage, and therefore the modulation wave form is not distorted in the process of rectification. (The contrary is true of the common square-law detectors, and of any ordinary detectors when operated at saturation or overload levels.) The diode detector operated to give peak detection does not have any important overloading effects because the peaks of the waves never become greatly positive; in fact, its operation is somewhat better at higher signal voltages, within reasonable limits.

Fig. 5 is the circuit diagram of a rectifying and indicating system which takes advantage of peak detection and other refinements and which has been found eminently satisfactory for many purposes. It is used principally to measure sinusoidal alternating voltages of commercial, audio or radio frequencies. Electrical constants will be given which have been employed in practice, but these may vary within wide limits without departing from the inherent improvements.

Vacuum tubes 60 and 63 may be of the 171A type having 20-ohm filaments and the triode structure of elements. Tube 60 is operated as a diode peak detector. The grid is tied to the positive filament terminal, and partly neutralizes the space charge around the filament, without serving any other function. Tube 63 is a direct-current amplifier in which the usual functions of the grid and plate are interchanged, the plate serving as control electrode and the grid as output electrode.

The unknown sinusoidal voltage to be measured is applied to the input terminals. The rectifier is thrown in operation by switch 59, and the unknown voltage is applied to the rectifier through condenser C (0.5 mfd.) which has a negligible impedance at frequencies of voltages to be measured, but prevents the flow of direct-current between input terminals and rectifier. Resistor R (5 megohms) is connected between the anode and the positive filament terminal, and serves to supply about one microampere initial anode current for tube 60. The rectifier current flows through R and builds up at point 52 a rectified voltage nearly equal to the peak of the unknown voltage.

The rectified voltage is applied to resistor 61 (1 megohm) and condenser 62 (0.1 mfd.) which filter out the alternating current component and supply a steady negative rectified voltage to the amplifier tube 63. Hence, this arrangement may properly be called a fluctuation-rejector; it tends to prevent over-loading of amplifier 63 by preventing the alternating current component of the rectified voltage from being impressed thereon.

Battery 64 (9 volts) supplies the space current of tube 63. Resistor 78 (22,000 ohms) is connected in series to make the total output resistance of tube 63 more nearly uniform thereby decreasing any distortion in the amplifying process. The microammeter 70 (100 microamperes full scale) carries the output current (about 400 microamperes) together with a nearly equal balancing current through resistor 79 (6200 ohms). Rheostat 77 (2500 ohms) is permanently adjusted to correct the slope of the calibration curve, as will be described below in more detail, but does not affect the current balance existing when switch 59 is disconnected. The meter is protected by switch 76 when not in use. The balancing current is controlled by voltage divider 75 (400 ohms).

The filaments are heated by battery 68 (6 volts). The rheostat 67 (2 ohms) is so adjusted that voltmeter 69 reads 5.5 volts. The filament voltages are further decreased by resistors 65 and 66 (each 6 ohms). The latter resistor 66 is so connected that the control electrode (plate) of tube 63 receives a slight initial negative bias through tube 60 and resistor 61. Resistors 71, 72, 73 and 74 (respectively 300, 210, 30 and 10 ohms) serve to divide the voltmeter voltage in required parts for output and balancing circuits. The filament battery therefore serves also to furnish the grid bias voltage and balancing current.

Because of the high resistance external circuits of tubes 60 and 63, the performance varies very little with tube variations, and battery voltages need not be maintained precisely constant.

The essential operation of the vacuum tube voltmeter of Fig. 5 will be described with reference to the curves of Fig. 6, which show the relations between the input alternating-current voltage and the amplified-rectified current change in meter 70. The full scale of this meter (100 microamperes) is not shown because the curves are simply linear at higher values.

As originally constructed, rheostat 77 was absent, and the initial reading of meter 70 was adjusted to zero by voltage divider 75. The calibration curves then secured were like the dot-dash curve (a), in that the meter readings did not correspond exactly to input-alternating-current voltages. It was noted that two corrections were required, one for the curvature near the origin, and another for the slope of the linear part of the curve.

In a subsequent design, correction was made for the curvature at the origin by supplying an excess balancing current of 2 microamperes in meter 70, and the slope was decreased to the correct value by the permanently adjusted rheostat 77. The rheostat 77 is therefore a sensitivity adjusting means. The final calibration

curve (b), drawn in a solid line, then shows an exact correspondence between meter current and input voltage, except at voltages below 5% of full scale. The result is a tube voltmeter which requires no reference to a calibration curve and is very accurate for measuring sinusoidal voltages from 0.5 to 16 volts (root-mean-square values). The input circuit has such a high impedance that the source of the unknown voltage may have as high as 3000 ohms impedance without causing any important error of calibration.

Because of the low filament temperatures and non-critical circuit values, there is only a minute required to reach temperature equilibrium. Thereafter, no readjustment is required during hours of use. An excessive overload does not injure the sensitive meter 70, because the plate current of tube 63 cannot fall below zero and therefore the net meter current on overload cannot exceed the balancing current, which is only about four times full scale deflection. Also the meter is not subjected to mechanical shock on overload because of the slight time lag in charging condensers C and 62 up to the rectified voltage.

Fig. 7 is a partial circuit diagram of a radio receiver employing peak detection but differing somewhat from Fig. 1. Individual batteries are shown in place of the more complex alternating current rectifiers, ripple filters and voltage dividers; it is understood that either may be employed with equal effectiveness in such circuits. Tube 80 is a screen-grid tube in the last stage of a multi-stage radio-frequency amplifier. Tube 81 is a triode with grid and plate tied together, so as to be equivalent to a diode, and is used to obtain peak detection. Tubes 82 and 83 are triodes used in the first two stages of the audio-frequency amplifier. Since the diode detector does not also amplify, it is necessary to employ one more audio-frequency stage than is customary with triode detectors. The tubes shown all have indirectly heated cathodes, the heating circuits being omitted from the diagram. Like Fig. 1, this receiver also has automatic volume control.

The voltage for the screen-grid of tube 80 is supplied by battery 98. The plate circuit includes battery 118 and auto-transformer 84. The transformer is broadly resonant over the broadcast band, and the primary is shunted by resistor 99 to make the response more nearly uniform.

The rectifier 81 receives the secondary voltage of transformer 84 through condenser C (50$\mu\mu$f.). Resistor R (0.2 megohm) is the leakage path between anode and cathode. Resistor 87 (0.25 megohm) and condenser 88 (250$\mu\mu$f.) serve to reject the radio-frequency component, but to pass the audio-frequency and direct current components of the rectified voltage to the grid of tube 82. The grid, or input, circuit of tube 82 operates as a voltage responsive device having a very high input impedance and little or no input current flow.

An automatic volume control arrangement supplies automatic grid bias voltages to the various tubes as follows: An initial negative voltage is applied to the entire detector circuit by battery 85 (3 volts). Added to this bias is a second negative component due to the rectified voltage across R. The second component serves to reduce the gain of certain tubes in the presence of a strong signal. The total bias voltage is applied to the grid of tube 82 through the radio-frequency rejector circuit 87, 88, and then also to the grids of the radio-frequency tubes preceding tube 80, through the audio-frequency rejector circuit including resistor 89 (0.5 megohm) and condenser 90 (0.01 to 0.1 mfd.). Since the radio-frequency tube 80 is required to maintain a fairly high gain, it is supplied with a smaller bias from a center tap on R, through the radio-frequency and audio-frequency rejector circuit including resistor 86 (0.5 megohm) and condenser 97 (0.01 to 0.1 mfd.).

The first two audio-frequency stages include tubes 82 and 83. Condenser 91 serves to suppress any residual radio-frequency fluctuations accompanying the amplified output of the detector. Battery 93 supplies the space current of tube 82, and battery 96 the grid bias of tube 83. Condenser 94 and resistors 92 and 95 are a resistance coupling network between tubes 82 and 83. The latter resistor 95 has a variable tap for use as a volume level control, in conjunction with the automatic volume control.

It should be understood that the element values expressed in connection with Fig. 7 and with succeeding figures are given merely to indicate values which will give good results, and should not be construed as limitations upon the invention.

Fig. 8 is a partial circuit diagram of another receiver employing both peak detection and automatic volume control. The tubes have indirectly heated cathodes. Screen-grid tube 100 is in the last radio-frequency amplifier stage. Tube 101 is a triode used as a diode peak detector, or rectifier, having two terminals, namely the anode and the cathode, the grid being used as anode, and the plate being tied to cathode and used as an electrostatic shield against any electrostatic coupling which would otherwise exist between at least one of the inner electrodes and other parts of the circuit. Tube 102 is in the first audio-frequency amplifier stage.

Tube 100 has a screen voltage supplied by battery 103 and plate voltage supplied by battery 104. An inductive radio-frequency transformer 105 couples the radio-frequency amplifier to the detector, and is designed to give nearly uniform response over the broadcast band.

The detector circuit of Fig. 8 is an improvement over Fig. 7 in that the inductive transformer 105 permits the condenser C to be inserted in the cathode lead instead of in the anode lead of the diode detector. The condenser C is connected in series between the cathode of the rectifier and the transformer 105 which is a source of alternating voltage for the rectifier. The required radio-frequency voltage is thereby impressed between anode and cathode, but radio-frequency currents are confined to the detector tube and condenser C, and are nearly absent from all other parts of the detector circuit. Condenser C (100$\mu\mu$f.) and resistor R (50,000 ohms) serve the same purposes described above. Resistor R is a leakage path across the rectifier, this leakage path having a high and substantially uniform impedance to modulation frequency and direct current and being connected between the lower end of the secondary winding of transformer 105 and ground, through battery 110. The somewhat lower value of R as compared with that in the preceding circuits, serves the added purpose of increasing the anode current and thereby making the response of tranformer 105 more uniform over the broadcast band. There is not associated with the rectifier any leakage path of lower resistance than R.

In the arrangement of Fig. 8, the cathode ter-

minal of the diode detector is required to be grounded (which is accomplished through battery 110). The condenser C is connected between the detector cathode and the lower end of the secondary coil of transformer 105. Since this ungrounded secondary coil is essentially an inductance, its resistance is low in comparison with that of R. The alternating voltage to be rectified is induced in this secondary coil from the primary coil of transformer 105. The upper end of the secondary coil is connected to the other terminal (the anode) of the rectifier.

As in the case of Fig. 7, initial and rectified grid bias components are furnished to the radio-frequency tubes by battery 110 (3 volts) and detector 101. The grid bias for the radio-frequency tubes preceding tube 100 is conducted through the audio-frequency and radio-frequency rejector circuit including resistor 106 (0.5 megohm) and condenser 107 (0.01 to 0.1 mfd.). A smaller grid bias is supplied to tube 100 from a center tap on R, through the audio-frequency and radio-frequency rejector circuit including resistor 108 (0.5 megohm) and condenser 109 (0.01 to 0.1 mfd.).

The audio-frequency amplifier is a voltage-responsive device having in its input circuit a voltage divider 116. The impedance of the amplifier, including the voltage divider, is much higher than that of the leakage path R. The audio-frequency amplifier can be connected either to the radio detector 101 or to the phonograph pick-up 114, by throwing switch 113 to (R_a) or (P_h) respectively. In the former case, the audio-frequency output of the detector is passed through the added radio-frequency, or carrier-frequency, ejector circuit including resistor 111 (0.25 megohm) and condenser 112 (100$\mu\mu$f.), in order to completely remove radio-frequency fluctuations. This latter circuit is also a direct-current rejector circuit because of the condenser 115. The pure audio-frequency output is then applied through condenser 115 (0.005 mfd.) to the voltage divider 116 (1 megohm). The variable tap on 116 to the grid of the audio amplifier serves to control the volume level of the audio-frequency amplifier output, when used with either radio or phonograph excitation. The battery 117 supplies the required grid bias to audio-frequency tube 102. The remaining side, or terminal, namely the cathode, of the input circuit of the audio amplifier is required to be grounded, as shown. Also, the grid of the audio amplifier is connected (through elements 111, 115 and 116) to the junction of condenser C and the secondary coil of transformer 105. Hence, the audio amplifier, or voltage-responsive device, is connected in parallel with condenser C and resistance R.

Fig. 9 is a partial circuit diagram of a radio receiver employing peak detection and automatic volume control, in which the detector circuit arrangement differs somewhat from the previously described arrangements. The tubes have indirectly heated cathodes. Screen-grid tube 120 is in the last radio-frequency amplifier stage. Tube 121 is a triode used as a diode peak detector, the grid being used as anode, and the plate being tied to cathode and to ground and used as an electrostatic shield against any electrostatic coupling which would otherwise exist between at least one of the inner electrodes and other parts of the circuit. Tube 122 is in the first audio-frequency amplifier stage.

Tube 120 has a screen voltage supplied by battery 125 and plate voltage supplied by battery 126. A tuned inductive radio-frequency transformer 127 couples the radio-frequency amplifier to the detector. The primary (left-hand) coil of this transformer is in the output circuit of tube 120. The secondary (middle) coil is tuned to resonance by variable condenser 128. In order to achieve certain advantages, the detector is not connected to the secondary coil, but to a tertiary (right-hand) coil coupled to the secondary.

The tertiary coil conveys to the detector only about one-third of the entire secondary voltage, thereby preventing excessive damping of the tuned circuit by the detector load conductance. The use of the separate tertiary coil also allows connecting the condenser C in the cathode return lead of the detector circuit (as in Fig. 8). Condenser C (250$\mu\mu$f.) and resistor R (0.1 megohm) serve the same purposes described above.

In Fig. 9 the radio-frequency tubes are supplied with initial grid bias voltages in a customary manner, indicated for tube 120 by series resistance 124 and radio-frequency by-pass condenser 123. An additional automatic grid bias is supplied from the rectifier voltage of the detector. The radio-frequency tubes preceding tube 120 receive the entire automatic bias through the radio-frequency and audio-frequency rejector circuit including resistor 129 (0.5 megohm) and condenser 130 (0.01 to 0.1 mfd.). Tube 120 receives a smaller additional bias through the radio-frequency and audio-frequency rejector circuit including resistance 131 (0.5 megohm) and condenser 132 (0.01 to 0.1 mfd.).

The audio-frequency output of the detector is passed to the detector output circuit through the radio-frequency rejector circuit including resistor 133 (0.25 megohm) and condenser 134 (250$\mu\mu$f.), in order to completely remove radio-frequency fluctuations. The pure audio-frequency output is then applied through condenser 135 (0.01 mfd.) to the voltage divider 136 (1 megohm). The variable tap on 136 serves to control the volume level of the audio-frequency amplifier output. The first audio-frequency tube 122 has any conventional grid bias provision, such as a series resistance 138 and an audio-frequency by-pass condenser 137.

The radio receivers of Figs. 1, 7, 8 and 9 have proven eminently satisfactory, especially with reference to the absence of distortion in the process of detection. The peak detection employed provides a rectified output which follows closely the envelope of the modulated radio-frequency signal. The achievement of peak detection is aided by the automatic volume control which maintains the detector voltage within the proper operating range, regardless of the applied signal strength.

In addition to the above improvements, a further refinement has been devised which is a desirable modification for peak detection circuits. This refinement is directed to a filtering arrangement, located at the output of the tube, and is especially useful in laboratory studies, as it enables the audio-frequency behavior of a peak detector to be determined precisely by measurements made with direct-current meters and without audio-frequency modulation of the radio-frequency signal. This refinement will be explained with reference to Fig. 10.

Fig. 10a shows the detector circuit of Figs. 8 and 9, reduced to its essential elements, namely: a diode rectifier; a radio-frequency input coil; the condenser C, and the resistor R. The radio-

frequency currents flow through condenser C, but the audio-frequency and direct-current rectified components flow through the resistor R. The direct-current load and the audio-frequency load on the detector are therefore effectively the same, and are equal to the resistance R. This is a desirable condition, because all the useful modulation of signals occurs in the audio-frequency range, and the rectified automatic bias voltages lie in the sub-audio-frequency or direct-current range. This rectifier circuit behaves alike in these frequency ranges. The audio-frequency and direct-current output components are not separated, however, and exist between the terminal represented by the arrow, and ground. The separation of these components requires additional circuit elements which generally destroy this condition of identity between direct-current load and audio-frequency load.

The structure of Fig. 10*b* has, in addition to the elements of Fig. 10*a*, a low-pass filter in which

$$R^2=L/C$$
$$f_c^2=1/\pi^2LC$$

The cut-off frequency f_c is located slightly above the audio-frequency range but much below the radio-frequency range of the signals to be received. The addition of this filter (which may include several sections like the one shown) further reduces radio-frequency fluctuations in the direct-current and audio-frequency output, but has a negligible effect on the direct-current or audio-frequency load impedance.

The filters in the succeeding Figs. 10*c* to 10*h* possess advantages over the filters of Figs. 10*a* and 10*b* in that they enable the direct-current and audio-frequency components of the rectified current to be separated. While the filter of Fig. 10*b* is shown nowhere else in Fig. 10, it is understood to be equally applicable to the other circuits of Fig. 10.

Fig. 10*c* shows, in place of the simple resistor R in Fig. 10*a*, a network R, R, L', C' which is known to have an effective resistance equal to R at all frequencies when the equation of condition is satisfied, namely:

$$R^2=L'/C'$$

This network has the ability to separate rapid fluctuations of the audio-frequency component from the relatively very slow fluctuations of the direct-current component, the dividing frequency being the resonant frequency of the reactive elements L' and C'. The audio-frequency component is shown as delivered from the secondary of an inductive transformer whose turns ratio, $N_1:N_2$, may have any desired value. The audio-frequency component exists between the terminals marked AF; and the direct-current potential exists between ground and the terminal marked DC.

Fig. 10*d* is similar to Fig. 10*c* except that the resistance R in parallel with the primary inductance is replaced by a resistance R $(N_2/N_1)^2$ across the secondary coil, the result being the same. A variable tap on this resistance may be used as a volume level control if desired, without any detrimental effect.

Fig. 10*e* is similar to Fig. 10*c*, except that the resistance R across the primary L' is replaced by a transmission line of proper impedance across the secondary coil.

Fig. 10*f* is an example using a different type of constant resistance network R, R, L', C'. The direct-current component flows in one shunt path R, C' and the alternating-current component in the other path R, L'.

Fig. 10*g* is an inverted form of Fig. 10*f*; and accomplishes the same result. In addition, a variable tap audio-frequency volume level control is indicated to be used if desired.

Fig. 10*h* employs a third form of constant resistance network R, L', L', C', C'. It has points of similarity with both Figs. 10*f* and 10*g*, and accomplishes the same result.

The direct-current output components from all the above circuits can be employed to advantage as automatic grid bias for automatic volume control, after the manner of Figs. 1, 7, 8 and 9.

The same equation of condition stated above holds for all cases of Figs. 10*c* to 10*h*. This utilization of constant resistance networks is not only useful in diode rectifier circuits, but is equally applicable and often very useful in the output circuits or other rectifier circuits, a[illegible]l of amplifier circuits. In all such cases there is the same advantage of uniform behavior toward both direct-current and audio-frequency components of the rectifier or amplifier output.

Many other applications of the improvements outlined above will be apparent but need not be discussed herein. They have also been found equally useful in superheterodyne receivers and in other special examples. It is obvious that the radio-frequency amplifiers referred to in the above cases can be replaced by amplifier arrangements of the superheterodyne or other special types.

What is claimed is:

1. A rectifying system comprising, in combination, a rectifier having two terminals, a source of carrier-frequency current modulated at modulation frequencies lower than said carrier frequency, a condenser connected in series with said source and said rectifier, a leakage path across said rectifier, and a voltage-responsive device having an impedance much higher than that of said leakage path, connected in parallel with said condenser, said path having a high and substantially uniform impedance to modulation frequency and direct currents.

2. A rectifying system comprising, in combination, a rectifier having two terminals, a source of carrier-frequency current modulated at modulation frequencies lower than said carrier frequency, a capacity element connected in series with said source and said rectifier, and a leakage element and a voltage-responsive element having an impedance much higher than that of said leakage element, connected in parallel with said condenser, the three parallel elements having a low impedance to carrier-frequency current and a high and substantially uniform impedance to modulation-frequency and direct currents.

3. A rectifying system comprising, in combination, a diode rectifier having two terminals, one of which is required to be grounded, a low-resistance ungrounded coil in which is induced an alternating voltage to be rectified, a condenser connected between one end of said coil and said grounded terminal, a connection between the other end of said coil and the other said terminal, a high-resistance leakage path across said condenser, a voltage responsive device having an impedance much higher than that of said leakage path and having one side which is required to be grounded, and a connection between the other side of said device and the junction of said coil with said condenser, whereby a rectified voltage is de-

veloped across said condenser and said device substantially free of fluctuations at the frequency of said alternating voltage.

4. The method of utilizing a space-discharge triode in a diode rectifier circuit, said triode having an outer electrode and two inner electrodes, which comprises operatively connecting said two inner electrodes in said circuit and connecting said outer electrode to ground, whereby the outer electrode is caused to shield said inner electrodes from the surrounding space.

5. A rectifying system comprising, in combination, a source of carrier-frequency voltage modulated at an audio-frequency, a thermionic diode rectifier, a condenser having low reactance at said carrier frequency and high reactance at said audio frequency, a series circuit including said source, said condenser and said rectifier, a high-resistance leakage path, without any leakage path of lower resistance, across said rectifier, an output circuit coupled to said rectifier, and a carrier-frequency rejector network interposed between said rectifier and said output circuit, whereby the latter is caused to function free of interference at said carrier frequency.

6. A rectifying system comprising, in combination, a source of carrier-frequency voltage modulated at an audio frequency, a thermionic diode rectifier, a condenser having low reactance at said carrier frequency and high reactance at said audio frequency, a series circuit including said source, said condenser and said rectifier, a high-resistance leakage path, without any leakage path of lower resistance, across said rectifier, an output circuit coupled to said rectifier, and carrier-frequency and direct-current rejector networks interposed between said rectifier and said output circuit whereby the latter is caused to function free of interference from carrier-frequency or direct-current components.

7. The method of utilizing in a diode rectifier circuit a space discharge tube having more than two electrodes, which comprises operatively connecting two of the inner electrodes in said circuit, and connecting an electrode outside of both said inner electrodes to ground for shielding against undesired electrostatic coupling which would otherwise exist between at least one of said inner electrodes and other parts of said circuit.

8. A rectifying system comprising, in combination, a rectifier having two terminals, a source of carrier-frequency current modulated at modulation frequencies lower than said carrier frequency, a capacity element connected in series with said source and said rectifier, and a leakage element and a voltage-responsive element having an impedance much higher than that of said leakage element, connected effectively in parallel with said condenser, the three parallel elements having a low impedance to carrier-frequency current and a high and substantially uniform impedance to modulation frequency and direct currents, and a carrier-frequency rejector network interposed between said rectifier and said voltage-responsive element, whereby said voltage-responsive element is caused to function free of interference at said carrier frequency.

HAROLD A. WHEELER.

Exhibit BB attached to and forming part of Affidavit of Harold A. Wheeler Civil Action 6677

May 19, 1936. H. A. WHEELER 2,041,273

AMPLIFIER VOLUME CONTROL

Original Filed July 7, 1927 2 Sheets-Sheet 1

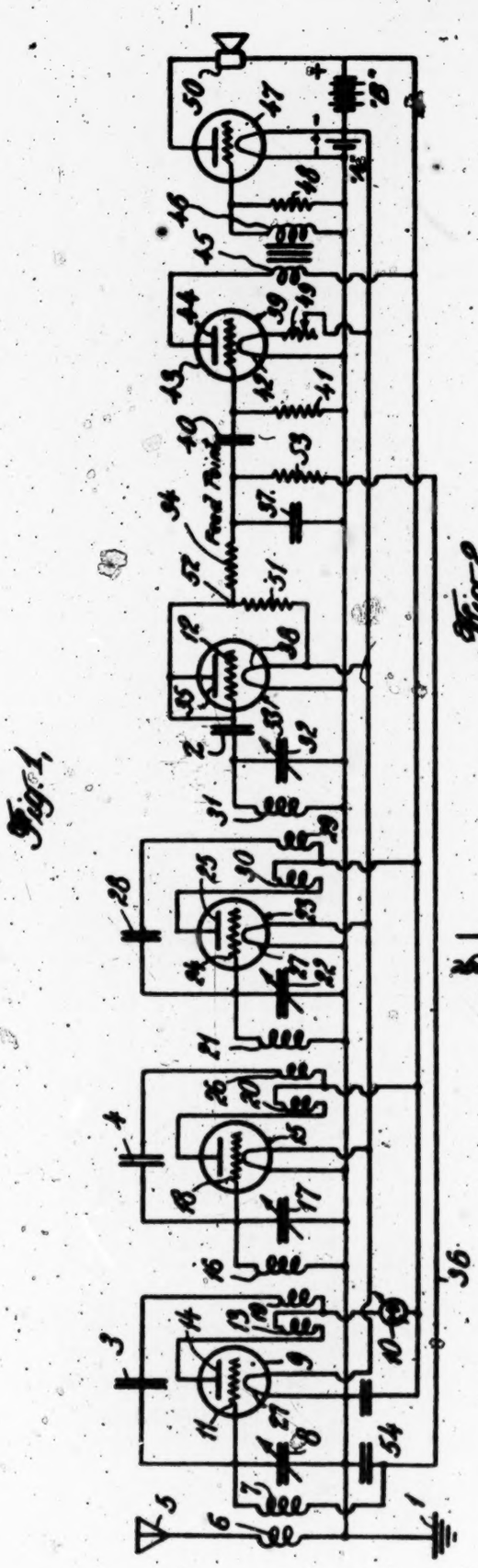


Fig. 1.

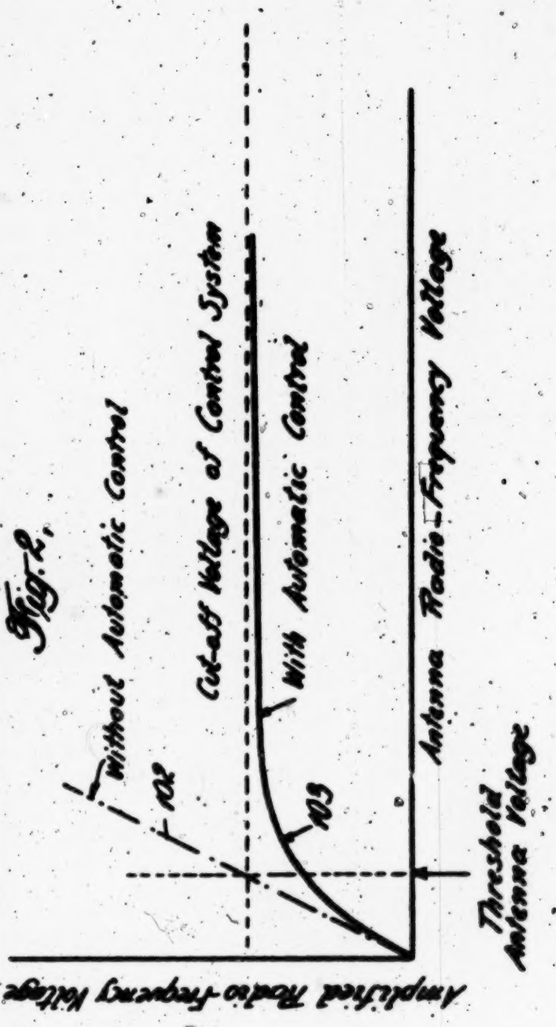


Fig. 2.

INVENTOR
Harold A. Wheeler
BY
Pennie, Davis, Marvin & Edmonds
ATTORNEYS

May 19, 1936. H. A. WHEELER 2,041,273

AMPLIFIER VOLUME CONTROL

Original Filed July 7, 1927. 2 Sheets-Sheet 2

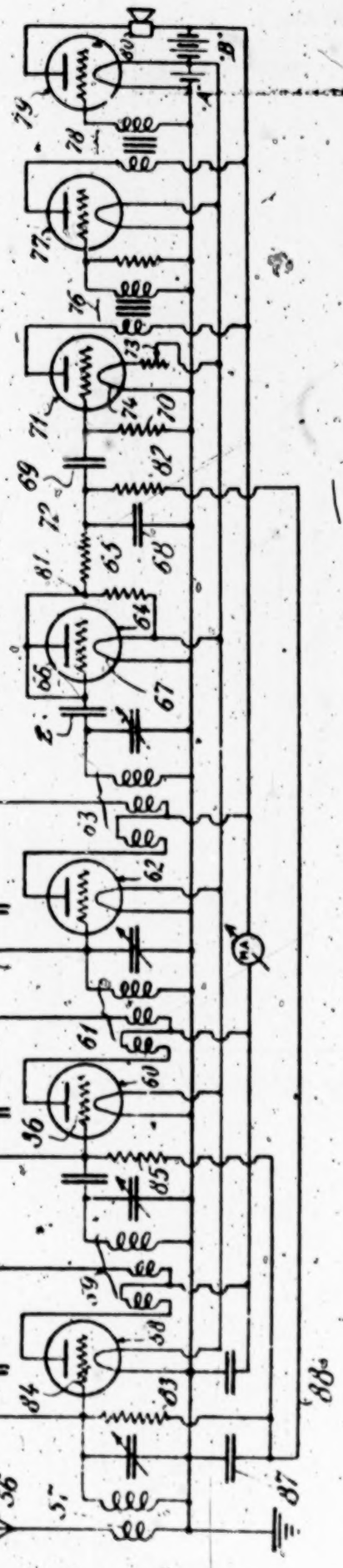


Fig. 3.

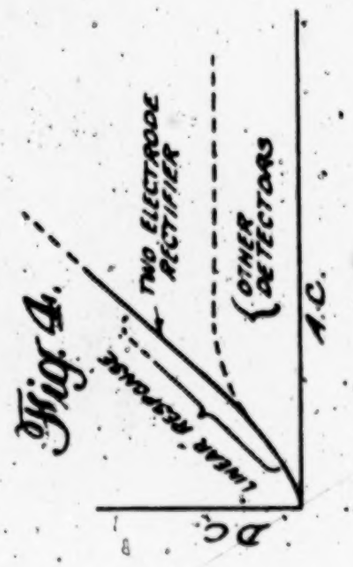


Fig. 4.

INVENTOR
Harold A. Wheeler
BY
ATTORNEYS

Patented May 19, 1936 2,041,273

UNITED STATES PATENT OFFICE

2,041,273

AMPLIFIER VOLUME CONTROL

Harold A. Wheeler, Great Neck, N. Y., assignor to Hazeltine Corporation, a corporation of Delaware

Original application July 7, 1927, Serial No. 203,879. Divided and this application August 27, 1932, Serial No. 630,739. Renewed June 27, 1935. In Great Britain July 3, 1928

12 Claims. (Cl. 250—20)

This invention relates to amplifiers, and more particularly to amplifiers utilized in modulated carrier-current signaling systems wherein the limit of amplification is automatically maintained substantially at a predetermined level.

This application is a division of application Serial No. 203,879, filed July 7th, 1927.

When amplifiers are employed for amplifying a signal voltage it becomes desirable for various reasons to control automatically the amplitude of this amplified signal voltage. To this end the present invention provides means for effecting automatic amplification control. Such an arrangement, for example, is particularly advantageous in radio receivers such as are employed for receiving broadcast signals, because it prevents the overloading of the last amplifier stage of the receiver, which overloading would result in distortion of the reproduced signal, as well as loud and harsh reproduction.

Another advantage resides in uniform reproduction of the amplified signal irrespective of whether the carrier-current signal is received from a nearby station or from a distant station, or from a high-power station, or a low-power station, since it has been found in former radio receivers that when the receiver was reproducing strong signals as from a nearby, or a high-power station, the audibly reproduced signal was very loud, whereas when the signal was received from a distant, or a low-power station, it was relatively weak, with the result that if signals were to be reproduced uniformly from both near and distant stations, and from high-power and low-power stations, it became necessary to readjust some volume controlling means in the receiver to compensate for these unequal signals.

It has also been a common experience in the use of former radio receivers that the reproduced signal was not uniform due to the phenomenon of "fading", whereby the received signal occasionally, or periodically, became much weaker, or faded almost to the point of inaudibility. Since the present invention provides an amplifier which automatically compensates for inequalities in the received carrier-current signal strength, when "fading" takes place the degree of amplification is correspondingly increased and the reproduced signal maintained at its former volume, so that a listener is unaware that variation of the received carrier-current signal is occurring. This automatic compensation for signal fading is especially advantageous in commercial radio telephony and like systems.

In present-day radio receivers in which operating current is derived from the municipal power system, it has been found that when there is considerable variation in the line voltage supply, the volume of the reproduced signal is not uniform. An additional advantage of the present invention is that of automatically compensating for such line voltage variations with the result that the reproduced signal is uniform in volume.

A still further advantage is the saving in plate current which is automatically effected during the reception of powerful signals, for the reason that this invention incidentally provides means for reducing the plate current of one or more amplifying tubes as the signal strength increases.

Fig. 1 is a circuit diagram of a complete radio receiver which includes the present invention, and consists of a three-stage radio-frequency amplifier followed by a rectifier, a two-stage audio-frequency amplifier, and a loud speaker, or other suitable indicating device.

Fig. 2 shows curves disclosing the relation between the radio-frequency antenna voltage and the radio-frequency amplified voltage, with and without the application of the present invention.

Fig. 3 shows a circuit diagram of a second embodiment of the invention in which there is disclosed a three-stage tuned radio-frequency amplifier, a rectifier, and a three-stage audio-frequency amplifier.

Fig. 4 shows graphically a comparison between the performance of the two-electrode valve or rectifier, and of the three-electrode detector.

Referring in detail to Fig. 1, there is shown an antenna 5 connected to ground 1 through the primary winding 6 of a radio-frequency transformer, the secondary winding 7 of which, tuned by a variable condenser 8, is connected at one point to the filament of the vacuum tube 9 in the first radio-frequency amplifying stage and at another point to the grid 11 of this vacuum tube. The output circuit of this vacuum tube extends from the filament system, through a high-voltage battery "B", a milliammeter 10, primary winding 13 of a second radio-frequency transformer to the anode or plate 14 of this vacuum tube. In order to neutralize the inherent capacity between the grid 11 and the plate 14, and thereby to prevent oscillations, and otherwise to increase the effectiveness of the present invention as hereinafter described, a neutralizing winding 16, electromagnetically coupled to winding 13, and a neutralizing condenser 3 are employed in the manner described in the U. S. patents to Hazeltine Nos. 1,489,228 and 1,533,898.

A second stage of radio-frequency amplifica-

tion including the vacuum tube 15 neutralized by cooperation of coil 26 and condenser 4, like the first stage, comprises the secondary winding 16 of the last-mentioned radio-frequency transformer tuned by a variable condenser 17 connected between the filament system of the vacuum tube 15 and the grid 18 thereof. The output circuit of this vacuum tube also includes the high-voltage battery "B" and a primary winding 20 of a second radio-frequency transformer, while the secondary winding 21 of this transformer tuned by a variable condenser 22 is included in the input circuit of a third stage of radio-frequency amplification which includes vacuum tube 23. The inherent capacity effective between the electrodes 24 and 25 is neutralized by a network including the neutralizing condenser 26 and the neutralizing winding 20 as described in the mentioned patents. The output circuit of the vacuum tube 23 includes the primary winding 30 of a third radio-frequency transformer and the high-voltage battery "B". The secondary winding 31 of this last-mentioned transformer, tuned by a variable condenser 32, is connected in the input circuit of a rectifier 33 which input circuit includes the fixed condenser 2. The rectifier employed may be of the type commonly known in the art as a two-electrode "Fleming" valve, or may consist of an equivalent such as a three-electrode vacuum tube, as shown, having its grid 12 and its plate or anode 35 directly connected together to comprise in effect a single anode.

In the absence of the present invention including the control circuit 36, to be described, the three-stage tuned radio-frequency amplifier, including the vacuum tubes 9, 15, and 23, functions in a manner well-known in the art to amplify selectively the incoming modulated-carrier signals of any carrier amplitude within a wide range, which are intercepted on the antenna 5. The output circuit of the rectifier 33 includes what may be termed a "rejector" circuit for stopping radio-frequency currents which have passed through the rectifier, and consists of a network including a resistance 34 and a by-pass condenser 37 connected between the anode 35 and the filament 38 of the rectifier. The output circuit of the rectifier is coupled to the input circuit of an audio-frequency amplifying vacuum tube 39 through an audio-frequency-pass filter including a fixed condenser 40 and an impedance 41 connected between the filament 42 and the grid 43 of this vacuum tube. As appears from the constants hereinafter given, the characteristics of this filter are such that it passes the audio-frequency component to the input circuit of the audio- or modulation-frequency amplifier, while preventing the unidirectional component from being impressed upon the input circuit thereof. The output circuit of this amplifier is connected between the filament 42 and plate 44 through the high-voltage battery "B" and the primary winding 45 of an audio-frequency transformer the secondary winding 46 of which is connected in the input circuit of a second audio-frequency tube 47, while a resistance 48 connected across the winding 46 serves to give the audio amplifier substantially uniform amplification over the desired frequency range. Instead of employing resistance 48, a closed copper band of suitable size may be placed around the transformer winding so as to be electromagnetically coupled thereto. A loud speaker or other reproducing device 50, or if required, a coupling device for a telephone system, is connected in the output circuit of the last audio-frequency amplifying tube 47. It is presumed that adequate precautions against undesired electromagnetic coupling between the various radio-frequency coupling transformers are included in all of the arrangements herein disclosed.

In accordance with the main feature of the present invention, means are provided to control automatically the degree of amplification effected in the radio-frequency amplifying stages. These means include a resistance 51, connected between the filament 38 and the anode, or output electrode, 35 of the rectifier, through which the pulsating rectified or converted current flows, thereby developing a negative voltage at terminal 52. This negative voltage is applied over conductor 36 through the resistance 53 and the secondary winding 7 of the first radio-frequency transformer to grid 11 of the first radio-frequency stage. Resistance 53, together with blocking condenser 54, is effective in producing a time constant predetermined to filter out and reject voltage fluctuations at frequencies of modulation of the selected and amplified signal, that is, any audio-frequency currents which otherwise might be applied from conductor 36 to the grid 11.

To complete the description of the system illustrated in Fig. 1 certain design data or constants are given herewith. It should be understood, however, that these, as well as all other constants appearing in the present specification, are mentioned merely by way of example in describing certain specific embodiments which in practice have proved eminently satisfactory, and are not intended to suggest any specific limitations as to the scope of this invention. Accordingly, fixed condenser 2 may be of 0.0005 microfarad; 37 of 0.0001 microfarad; 54 of 0.01 microfarad; 40 of 0.005 microfarad; resistance 51 of 1 megohm; 34 of 1 megohm; and 41 and 53 of 2 megohms each.

In the operation of the receiver shown in Fig. 1, a signal modulated-carrier intercepted on the antenna 5 is selected and successively amplified through the neutralized radio-frequency stages indicated by the vacuum tubes 9, 15, and 23 connected in cascade. This amplified signal voltage is then rectified by the rectifier 33, and the rectified pulsating current is successively amplified by the audio amplifying stages including vacuum tubes 39 and 47, after which it may be reproduced as sound by the loud speaker 50.

The high resistance 51, connected to the cathode or filament 38 and the anode 35 of the rectifier, through which a small space current flows in absence of signal output from the radio-frequency amplifier, maintains the anode normally negative relative to at least a part of the filament of the rectifier. Since all the filaments are connected in parallel, the rectifier filament is maintained at substantially the same potential as the filament 27 of the first radio-frequency amplifier tube 9. Therefore, the resistance 51 is connected effectively between the rectifier anode 35 and the amplifier filament 27, and thereby determines the normal potential of the rectifier anode negative relative to at least a part of the amplifier filament or cathode. The resistance 51, being on the order of 1 megohm, which is of a higher order than that of the resistance to current in the more conductive direction of ordinary commercial types of vacuum tubes used as diodes, is therefore a controlling factor in affecting the operation of the rectifier circuit. By virtue of the

proportions of the condenser 2 and the resistance 51, for example as given above, and the resistance of the rectifier tube 33, the rectifier circuit has a time constant substantially less than the period of the highest frequency of strong modulation.

When the rectified or converted signal voltage across the resistance 51 increases with signal output beyond a predetermined value, there is developed at the anode terminal 52 sufficient negative biasing voltage which in turn is impressed, through the conductor 36, upon the grid, or control electrode, 11 of the vacuum tube 9, to reduce the amplification of this tube. Conversely, it will be apparent that as the magnitude of the rectified current flowing through resistance 51 decreases with decreasing signal strength, the direct voltage at terminal 52 becomes less negative, and the negative biasing voltage impressed upon the grid 11 also diminishes so that the vacuum tube 9 effects an increased degree of amplification. In this manner, the radio-frequency voltage applied to the input of the rectifier is maintained at a nearly constant predetermined value, and the volume of the reproduced signal is substantially uniform under all conditions. In other words, the carrier amplitude at the rectifier is maintained above a predetermined lower limit, or within a range having a predetermined lower limit, the rectifier circuit by virtue of the aforementioned proportions of its component elements having the characteristic of linear rectification of a strongly modulated signal of any carrier amplitude within this range. The level at which the volume is maintained uniform is determined by adjustment of rheostat 48, which controls the heating current in the filament 42 of the first audio-frequency amplifying tube 39.

In the above operation it is noted that the two-electrode or diode rectifier 33 functions as the detector and also effects rectification of the carrier current to control the amplification in the carrier-current amplifier of the receiver. The audio-frequency component of the detector output is coupled to the input circuit of the audio-frequency amplifier for further amplification.

The neutralization of the grid-plate capacity of the radio-frequency amplifying tubes is, in combination with the present invention, particularly valuable in that it allows an increase in the effectiveness of the amplification control, because such neutralization prevents radio-frequency energy from passing through the grid-plate capacity of the tubes. Thus the relay action of the tubes is almost entirely subject to the control by grid bias voltage provided in accordance with this invention.

The time required for operation of the control system would ordinarily be determined by the lowest audio-frequency modulation which must be reproduced. Fading, for example, might be considered a form of modulation; the frequency of the rise and fall of signals due to fading being the frequency of modulation. If this frequency of modulation be increased sufficiently, the effect will be audio-frequency modulation. It will thus be seen that if the automatic control attained by the present invention be allowed to respond too quickly, it will tend to smooth out the desired modulation of the signals at the lower audio frequencies. Hence, a time constant of operation is chosen which will be greater than the period of the audio frequencies which the system is intended to amplify. This time constant of the control circuit is equal to the product of the series resistance and the shunt capacitance of the grid bias circuit, represented in Fig. 1 by resistance 53 between the conductor 36 and the anode terminal 52 in the direct-current connection back to the grid 11, and condenser 54 connected between the amplifier filament 27 and a point on conductor 36. Since the time constant can always be reduced to a value equal to the period of the lowest modulation frequency, it may readily be set to meet the requirements of nearly any special case which may arise. For example, a value of two million ohms resistance and of 0.1 microfarad capacitance gives a time constant of one-fifth of a second, which does not appreciably affect the modulation of frequencies above five cycles. While this constant is greater than required from the point of view of satisfactory audio-frequency quality in the reproduction of music, there appears to be no need for more rapid control under the conditions usually encountered. The use in this connection of condensers of large capacitance, such as one-tenth microfarad, likewise introduces another convenience in that the condensers may also serve to by-pass radio frequencies in order to prevent undesired coupling between the detector circuit and the first radio-frequency amplifying tube because of some impedances common to those two portions of the apparatus.

The milliammeter 16 is connected in the anode circuit of the amplifying vacuum tube 9. On receipt of an amplified signal at the detector, the effect of the control circuit is to reduce the amplification in the tube 9, and incidentally to reduce the plate current through the milliammeter 16. When the receiver is tuned to the signal frequency, a minimum amplification in this tube is required, so that the plate current of tube 9 then reaches a minimum value, and the milliammeter 16 so indicates. Thus the milliammeter visually indicates the condition of resonance.

For a better understanding of the present invention reference is made to Fig. 2 from which it will be appreciated that in a system similar to that illustrated in Fig. 1, but in which no means for automatically limiting the degree of amplification is included, the amplified radio-frequency voltage is proportional to the radio-frequency antenna voltage, as indicated by curve 102. When, however, the present invention is employed in such an amplifier, the relation between the radio-frequency antenna voltage and the amplified radio-frequency voltage is indicated by curve 103 from which it will be seen that when at least a certain predetermined radio-frequency antenna voltage is present, (herein referred to as the "threshold antenna voltage") the amplified radio-frequency voltage approaches—but is always less than—another certain predetermined voltage value (herein referred to as the "cut-off voltage").

The modification illustrated in Fig. 3 is an especially desirable form of the present invention, and includes antenna 56, connected by means of a transformer 57 to a neutralized three-stage tuned radio-frequency cascade amplifier including the vacuum tubes 58, 59, and 62 coupled by transformers 59 and 61. The last stage of the amplifier is connected by a transformer 63 to a two-electrode rectifier 64 of the type already described, the output circuit of which, including the resistance 65, is connected between the anode 66 and filament 67 of the rectifier, as previously explained. Resistance 72 and condenser 68 associated with this output

circuit, constitute a "rejector" network which filters out the radio-frequency current component in the output circuit of the rectifier 84, while the network including condenser 89 and resistance 78 constitutes an audio-frequency-pass filter for coupling the output circuit of the rectifier to the input circuit of the audio-frequency amplifier which includes vacuum tube 71. Rheostat 73 controls the heating current supplied to the filament 74 of this vacuum tube, and thereby permits a manual adjustment of the volume of the reproduced signal desired by the listener. Audio-frequency transformer 76, which is preferably of a low ratio of transformation, couples the output circuit of vacuum tube 71 to a second audio-frequency amplifying tube 77. This last vacuum tube in turn is coupled by a second audio-frequency transformer 78 to a third audio-frequency amplifying tube 79 in the output circuit of which there is included a loud speaker 80.

In this arrangement automatic amplification control is effected in the same manner as in Fig. 1, except that in this instance the radio-frequency voltage of the signals intercepted by the antenna 86 is successively amplified by three neutralized tuned radio-frequency amplifying stages including the vacuum tubes 88, 90, and 92, of which two are controlled in accordance with the present invention: The amplified radio-frequency current is rectified by the rectifying valve 94, and successively amplified at audio-frequency by the vacuum tubes 71, 77, and 79. The rectified current in the output circuit of the rectifier flows through the resistance 95, and thereby develops a negative voltage at the terminal 81, which voltage is applied through the impedances 72, 82, 83, and 85 to the grids 94 and 96 of the radio-frequency amplifying tubes 88 and 90. By thus simultaneously controlling the degree of amplification of two successive radio-frequency amplifying stages a greatly increased uniformity of regulation is attained. Resistance 82 and the condenser 87 constitute an audio-frequency-stop filter, so that substantially only direct-voltage is impressed upon the grids 94 and 96. It will be understood that the voltage developed at terminal 81 is a function of the amplified radio-frequency voltage delivered to the input circuit of the rectifier by the radio-frequency amplifying tubes 88, 90, and 92, and therefore, as the negative voltage at terminal 81 tends to increase with the increased signal, the resulting increase of biasing voltage impressed upon the grids of the tubes 88 and 90 limits the degree of amplification effected in the radio-frequency stages including those tubes.

In this arrangement the constants for the various resistances and condensers may, for example, be the same as those for the corresponding elements in Fig. 1. In addition the grid resistances 82 and 85 may have a value of 2 megohms each; and the grid condensers connected at the junction of these resistances and the grid electrodes 94 and 96 may each be of 0.001 microfarad capacity.

In Figs. 1 and 3 the variable tuning condensers are grounded in order to eliminate undesired capacity effects as well as to make it practicable to connect the condensers on a single shaft for unicontrol, if desired.

There are advantages attending the use, in connection with the present invention, of the two-electrode rectifier circuit typified by Figs. 1 and 3, which may not be apparent from the foregoing discussion. It is impossible to overload this type of rectifier, and the rectified output voltage is directly proportional to the applied alternating signal voltage when this voltage is large, say over two volts. The control system in the circuits of the figures referred to requires a large operating voltage, say ten volts, so that the latter condition of large signal voltage is realized. No such simple relationship is possible in a three-electrode detector, whose rectified output never exceeds a limiting upper value, and is never proportional to the applied voltage, except over a very small range of voltages. This distinction will be seen from Fig. 4 where the abscissae "A. C." represent the alternating signal voltages, whereas the ordinates "D. C." represent the rectified output voltages. It is well known that the linear curve is much more desirable when minimum distortion of a modulated signal is desired, and it will be observed from Fig. 4 that the preferred type of curve is obtained from the two-electrode rectifier.

A further advantage of the "linear" type detector with the automatic volume control connection and a visual resonance indicator in the anode circuit of the amplifier whose grid bias is being automatically controlled, lies in the fact that the visual resonance indicator will give an indication which is proportionate to the received signal intensity. This follows from the fact that the negative grid bias on the amplifier is directly proportional to the strength of the signal; and hence the anode current bears a similar relation to the signal.

While a three-electrode detector is useful in certain arrangements for relatively small applied voltages, the rectified output voltage is approximately proportional to the square of the applied voltage, i. e., to the power associated with the applied voltage. For this reason the rectified voltage increases with the carrier wave modulation. When such a detector is used in an automatic amplification control system, the total power from the radio-frequency amplifier is maintained at a substantially constant level, the amplitude of the carrier wave being decreased in the presence of modulation. It is desirable to maintain the carrier wave at a constant amplitude at the output of the amplifier, and this is accomplished by the diode rectifier as shown in Figs. 1 and 3. The control system maintains constant the average signal amplitude which is equal to the carrier wave amplitude and independent of the degree of modulation.

It will be observed that in a system employing a two-electrode rectifier such as represented by valve 23 of Fig. 1, and 84 of Fig. 3, the control bias voltage is independent of the "B" or anode battery voltage. Since the diode rectifier is not an amplifier, is not critical, and requires neither anode nor biasing battery, no adjusting devices are required.

In the foregoing description, tuned radio-frequency receivers of the neutralized types have been referred to. It should be pointed out, however, that the present invention may be employed with equal effectiveness to any radio receivers in wired radio and space radio systems, and that it has been found especially applicable to receivers of the super-heterodyne type.

It is well known that the common "B" battery may be replaced by a source of rectified and filtered alternating current, and, in the event that tubes having indirectly heated cathodes are used instead of those having incandescent directly heated filament cathodes, the common "A" battery may be replaced by a source of alternating current.

For these reasons the present disclosure of typical embodiments of the invention should not be construed as a limitation, but merely as illustrative of the principles of the invention, the scope of which is defined in the appended claims.

I claim:

1. An audion amplifier including an audion for signal wave amplification, an output circuit, and means limiting fluctuations in said output circuit due to variations in the strength of an incoming signal, said means comprising a diode rectifier for incoming signal energy, and means for impressing upon the grid of said audion a direct current bias voltage derived from said rectifier, said rectifier being of the type having approximately linear relation between direct current output and radio frequency input.

2. In a carrier wave receiving system, a rectifier of received signals coupled to a signal indicating device, and means automatically maintaining the output of said rectifier within a narrow range for wide variations in amplitude of the received carrier, the output of said rectifier being, throughout said narrow range, linearly related to its input, thereby to minimize distortion of signals relayed to said indicating device.

3. In a carrier wave receiving system, a rectifier of received signals coupled to a signal indicating device, the output of said rectifier being, over a limited range, linearly related to its input, and means automatically maintaining the output of said rectifier within said linear range for wide variations in amplitude of the received carrier, thereby to minimize distortion of signals relayed to said indicating device.

4. In a carrier wave receiving system in cascade, a vacuum tube having a control grid, a rectifier, and a signal indicating device, and means applying to said control grid a biasing voltage derived from said rectifier for automatically maintaining the rectified output within a narrow range for wide variations in amplitude of the received carrier, the output of said rectifier being, throughout said narrow range, linearly related to its input.

5. In a carrier wave receiving system in cascade, a vacuum tube having a control grid, a rectifier, and a signal indicating device, the output of said rectifier being throughout a limited range, linearly related to its input, and means for applying to said control grid a biasing voltage derived from said rectifier for automatically maintaining the output of said rectifier within said linear range for wide variations in amplitude of the received carrier.

6. In a carrier wave receiving system, a rectifier, means relaying high frequency signals thereto including a vacuum tube having a control grid, means applying to said control grid a biasing voltage derived from said rectifier for automatically maintaining the rectified output within a range which is small compared to variations in carrier amplitude impressed on said system, the output of said rectifier being throughout said small range, linearly related to its input, whereby said biasing voltage is determined solely by the carrier amplitude unaffected by modulation thereof.

7. In a carrier wave receiving system, a rectifier, means relaying high frequency signals thereto including a vacuum tube having a control grid, the output of said rectifier being, throughout a limited range, linearly related to its input, and means for applying to said control grid a biasing voltage derived from said rectifier for automatically maintaining the rectified output within said linear range for wide variation in amplitude of the received carrier, whereby said biasing voltage is determined solely by the carrier amplitude unaffected by modulation thereof.

8. In a modulated-carrier signal receiver for receiving a signal of any carrier amplitude within a wide range, a rectifier having the characteristic of linear rectification of a strongly modulated signal of any carrier amplitude above a predetermined lower limit, and means responsive to the carrier amplitude for automatically maintaining the carrier amplitude at said rectifier within a range determined by said lower limit and the overload point of the receiver.

9. In a modulated-carrier signal receiver for receiving a signal of any carrier amplitude within a wide range, a diode rectifier having the characteristic of linear rectification of a strongly modulated signal of any carrier amplitude above a predetermined lower limit, the circuit of said rectifier having a load impedance much greater than the diode resistance to current in the more conductive direction, and means responsive to the carrier amplitude for automatically maintaining the carrier amplitude at said rectifier within a range immediately above said lower limit and of lower order of magnitude than the range of the received signals.

10. In a modulated-carrier signal receiver for receiving a signal of any carrier amplitude within a wide range, an amplifier in which the amplification varies with a bias voltage applied thereto, a rectifier having the characteristic of linear rectification of a strongly modulated signal of any carrier amplitude above a predetermined lower limit, means for coupling the output of said amplifier to said rectifier, and means for applying to said amplifier as a bias voltage a rectified-carrier voltage from said rectifier, and thereby automatically maintaining the carrier amplitude of said amplifier output within a range predetermined by said lower limit and the overload point of the receiver.

11. In a modulated-carrier signal receiver for receiving a signal of any carrier amplitude within a wide range, an amplifier in which the amplification varies with a bias voltage applied thereto, a rectifier having the characteristic of linear rectification of a strongly modulated signal of any carrier amplitude above a predetermined lower limit, said rectifier circuit having a time constant substantially less than the period of the highest frequency of strong modulation, means for coupling the output of said amplifier to said rectifier, and a coupling circuit for applying to said amplifier a bias voltage which varies with the rectified carrier voltage from said rectifier, said amplifier, rectifier and coupling circuit being relatively proportioned to maintain the carrier amplitude at said rectifier within a range immediately above said lower limit and of a lower order of magnitude than the range of the received signals, and said coupling circuit having a time constant greater than the period of the lowest frequency of strong modulation, for causing said bias voltage to vary only with the signal carrier amplitude and not with signal modulation.

12. In a modulated-carrier signal receiver for receiving a signal of any carrier amplitude within a wide range, a diode rectifier, a condenser connected in series with said rectifier, a leakage path across said rectifier having to modulation-

frequency current and direct current a substantially uniform resistance of a higher order than that of said rectifier to current in its more conductive direction, whereby said rectifier has the characteristic of linear rectification of a strongly modulated signal of any carrier amplitude above a predetermined lower limit, and means responsive to the carrier amplitude for automatically maintaining the input carrier amplitude at the rectifier within a range immediately above said lower limit and of a lower order of magnitude than the range of the received signals.

HAROLD A. WHEELER.

No. 66 77. Daniel Patton

(9)

The cause was then continued to the December Term, 1947, when on Febuary 2, 1948, the following Countermotion for Summary Judgment was filed by the defendant:

DEFENDANT'S COUNTERMOTION FOR SUMMARY JUDGMENT.

[Filed February 2, 1948.]

Defendant moves this court for a summary judgment dismissing the complaint herein on the following grounds:

1. Plaintiff's patents have been so misused by plaintiff and its predecessor as to render them unenforceable and, hence, plaintiff is not entitled to any recovery from defendant. Said misuse has included:

(a) Requiring its licensees to apply patent marking notices to radio sets made by them, which notices include restrictions as to the permitted use of the sets by the purchasers thereof.

(b) Requiring its licensees to mark on radio sets made by them patents which are not used in said sets and which are invalid.

(c) The coercive entry of a consent decree on December 3, 1941, in the case of *Halzeltine Corporation* v. *Automatic Radio Manufacturing Company, Inc.*, Superior Court, Suffolk County, Massachusetts, Equity No. 47,229; which decree is void as being contrary to public policy.

(d) Requiring its licensees to sign license agreements which are so oppressive in their terms as to be contrary to public policy and void.

(e) Requiring its licensees to pay royalties on all radio sets sold by them, whether or not said sets employ the inventions of any of plaintiff's patents and whether or not said patents are invalid.

(f) Improperly using its patents to compel others to assign to plaintiff, or its predecessors, rights under patents owned by them.

(g) Refusing to grant a license under any one or more of its patents to anyone who refuses to take a license under all.

(h) Suing and threatening to sue, and otherwise harassing customers of radio manufacturers refusing to take a license under its patents and coercing radio manufacturers to take licenses under its patents by threats of repeated, expensive law suits.

(i) Forcing its licensees to pay royalties on radio tubes purchased by them from the Radio Corporation of America, which company has a license from plaintiff to make and sell said tubes under plaintiff's patents and which tubes were, therefore, freed from said patents at the time of their purchase, thereby enforcing the payment of royalties on unpatented tubes.

(j) Amassing a vast number of radio patents not for use, but for the purpose of coercing the payment of royalties on all radio sets.

2. The license agreement between the parties is invalid and void and unenforceable against defendant for the following reasons:

(a) Said agreement is so oppressive and unconscionable in its terms as to be void as against public policy.

(b) Said agreement was breached in its inception, and has been continuously breached since, by the failure of plaintiff and its predecessors to prosecute alleged infringers of its patents diligently.

(c) For failure of consideration, plaintiff and its predecessors having no valid patents covered by said license, and for eviction from said license due to the decisions of the courts holding the best of said patents invalid and not infringed during the term of the license.

(d) Because plaintiff's patents have been misused and are unenforceable.

(e) Said agreement requires the payment of patent royalties on devices and parts thereof not covered by plaintiff's patents; and on parts already licensed and thereby freed from plaintiff's patents.

This motion is made on the ground that there is no genuine issue as to any material fact necessary to support this motion.

In support of said motion defendant relies upon the pleadings herein, the license agreement between the parties, copy of which was filed with the complaint as Exhibit A, defendant's interrogatories and plaintiff's answers thereto, including Exhs. B through N annexed to said answers, the motion of plaintiff for a summary judgment, the affidavits supporting and opposing plaintiff's said motion, and the attached affidavit of George K. Woodworth.

GEORGE K. WOODWORTH,
Attorney for Defendant.
Office and P.O. Address
19 Congress Street
Boston 9, Massachusetts

FLOYD H. CREWS
DARBY & DARBY
Of Counsel
Office and P.O. Address
405 Lexington Avenue
New York 17, N. Y.

Dated: Boston, Massachusetts
February 2, 1948

Affidavit of George K. Woodworth in Support of Defendant's Counter Motion for Summary Judgment.

Commonwealth of Massachusetts
County of Suffolk, ss.:

George K. Woodworth, being first duly sworn, deposes and says:

1. I am an attorney at law, with an office at 19 Congress Street, Boston 9, Massachusetts, and specialize in the practice of patent law.

Automatic Radio Manufacturing Company, Inc., the defendant in this action, which is engaged in the manufacture and sale of radio receivers, has been a client of mine in connection with its patent problems arising in this business since 1925.

This affidavit is made on information and belief, except as to matters of public record and as to matters stated to be within my own knowledge.

2. (a) The Hazeltine Corporation, of which plaintiff is a wholly owned subsidiary, was organized in 1924 to exploit the invention of Professor Hazeltine, of the Stevens Institute of Technology, of the neutrodyne radio circuit. Professor Hazeltine took out three patents to cover this circuit, all of which were held valid and infringed by the courts as follows:

Hazeltine Patent No. 1,450,080 held valid and infringed at 18 Fed. (2d) 662.

Hazeltine Patent No. 1,489,228 held valid and infringed at 21 Fed. (2d) 643.

Hazeltine Patent No. 1.533,858 held valid and infringed at 21 Fed. (2d) 643
34 Fed. (2d) 635, certiorari denied 74 L. Ed. 237
47 Fed. (2d) 573
52 Fed. (2d) 504
59 Fed. (2d) 203

(b) There are several corporations bearing the name of Hazeltine. All are under common ownership and are referred to herein as "Hazeltine".

(c) Professor Hazeltine himself and Hazeltine collected millions of dollars in royalties under these neutrodyne patents.

(d) The screen grid tube was introduced commercially in 1927 and came into general use in 1929. It made Professor Hazeltine's neutrodyne patents obsolete and they have not been used in any radio set since about 1929.

(e) Hazeltine had in the meantime, however, started assembling patents by purchase and by hiring engineers in the hope that they would make patentable inventions. It had also pursued a very aggressive patent enforcement policy, filing large numbers of suits and threatening many others. On the basis of this aggressive policy and its added patents it has continued to collect royalties from the radio industry up to the present time, and still collects royalties, although no patent owned by Hazeltine has ever been held to be valid and infringed since the original Hazeltine neutrodyne patents.

(f) Hazeltine has continued through the years to be very active in assembling patents originating in its own laboratories and acquired from others, so that at the present time, as stated in Mr. Binns' affidavit, it has something like 770 patents and patent applications.

(g) Hazeltine operates on a fundamental fallacy. That fallacy is that inventions can be made to order. It hires engineers and puts them to work in the hope that they will make patentable inventions of value, and files patent applications on every engineering advance originating with its engineers on the erroneous assumption that every engineering improvement made, however trivial, is entitled to patent protection. No manufacturer has ever been accused of infringing more than 22 Hazeltine patents.

(h) Hazeltine does not, however, spend any very substantial portion of the monies received in royalties from the manufacture of radio receivers, in research looking to the improvement of radio

receivers. Indeed, during 1941, the last year prior to the war, not more than some 5% of Hazeltine's income was put into research on radio receivers and probably less than 5% was expended thereon. In that year 80% of its research money was spent on television as shown in paragraph numbered 7(a) hereof and it has paid taxes, dividends, litigation, expenses, royalty collection expenses, patent expenses and overhead, so that probably considerably less than 50% of its patent royalty income went into any kind of research. If we assume 50%, and assume that the entire balance of 20% of research money went into radio research, that makes only 20% of 50%, or 10% of radio royalties put into radio research. Even on this high figure, considering the markup from manufacturer to consumer, for every dollar paid by the public as tribute to Hazeltine patents in 1941, not more than 3 cents was spent by Hazeltine in radio research on radio receivers. During the year 1946 Hazeltine paid its officers and directors in excess of $250,000.

(i) Hazeltine has collected over the years, on the order of $50,000,000 in royalties from radio manufacturers for the manufacture of radio receiving sets. As the mark-up on any manufactured article from the manufacturer to the ultimate consumer is 3 to 1 or more, this represents some $150,000,000 that the public has paid on account of the Hazeltine patents, but only some 5% or less of this money has been paid for sets using the Hazeltine neutrodyne circuit. The remainder, or well over $100,000,000, was paid for patents which were invalid or were not being used, or both.

(j) The Bell Telephone Laboratories makes a practice of hiring regularly highly selected engineering graduates of the best engineering schools in the United States. From these engineers it derives an average of approximately one invention per man for each ten years of service. Some 1% of these engineers produce hundreds of inventions each. If these prolific inventors were eliminated from the analysis, the remaining engineers would pro-

duce something like an average of one invention for each 30 or 40 years of service, or an average of one in a lifetime, or less.

(k) It will thus be seen that inventors cannot be hired by any process of selection. It is just as difficult to predict which of a group of brilliant young men will be an inventor as it is to predict what boy will make a fortune. Inventors cannot be selected, and inventions cannot be made on order, nor, on the basis of all the evidence available, does it appear that engineering or other technical training increases the likelihood that a person will make inventions.

(l) If a company hires ten research men and puts them to work in a laboratory, there is no assurance that a valuable invention will come out of that laboratory. There is a large element of luck involved, and that element of luck includes the nature of the work to which the research men are assigned. The Patent Office records show thousands of arts which have advanced for years and then become stagnant.

(m) In the radio art, the Radiola 66 radio receiver was produced by the Radio Corporation of America in 1929, and marked with 104 patents belonging to the RCA radio patent pool, all of which have now expired. That radio receiver was a modern high quality receiver by today's standards, and could not be distinguished from a 1948 receiver in a blindfold test. It is highly questionable whether a patentable invention relating to radio receivers has been made since 1929 or for some years prior thereto. At the present time, the Radio Corporation of America does not have a single patent of its own or among the 10,000 patents of the radio patent pool which it controls, which has been adjudicated and held valid. Such improvements as have been made in radio receivers since 1929 have been in the nature of detailed engineering improvements reducing the cost of manufacture, and changes in styling of the cabinets, if these be called improvements.

3. There is now pending in the Superior Court of Suffolk County, for the Commonwealth of Massachusetts, a bill of review to set aside the final decree entered in that Court on De-

cember 3, 1941, in the case of *Hazeltine Corporation* v. *Automatic Radio Manufacturing Company, Inc.*, Equity No. 47,229, on the ground that said decree is void and of no effect for the reason that it is contrary to public policy as established by the Supreme Court of the United States in the case of *Pope* v. *Gormully*, 144 U.S. 224, in that it decrees that all of Hazeltine's hundreds of patents are valid for their entire terms and also decrees the validity and infringement of Hazeltine patents which had expired prior to the entry of said decree. A copy of said decree is Exhibit R attached to the affidavit of John R. Binns filed with plaintiff's motion for summary judgment in this case. The Hazeltine patents listed in said decree as being valid and infringed, which patents had expired at the time of the entry of said decree, with the date of expiration of each, are as follows:

Patentee	Patent No.	Issued	Expired
Latour	1,382,738	June 28, 1921	June 28, 1938
Latour	1,405,523	Feb. 7, 1922	Feb. 7, 1939

4. (a) The license agreement between the parties hereto which was entered into to be effective as of September 1, 1942 (Exhibit A attached to the complaint), contains in Article IV, Section 1, found on page 5 of said agreement, a clause requiring defendant to pay royalties on all radio sets made by it, whether said sets used any one or more, or none, of plaintiff's patents. Said provision reads as follows:

> "Section 1. Licensee agrees to pay to Licensor upon each complete apparatus identified in Article III, Section 2, sold by Licensee during continuance of this license royalties as follows: . . ."

That said provision is intended to require payment on all sets made by defendant, and has been so interpreted and enforced by plaintiff, is proved by plaintiff's motion for summary judgment, which states on page 2 that in support of the motion, plaintiff relies on—

"(b) the license agreement between the parties, a copy of which was filed with said complaint as Exhibit A, which provides for the payment of royalties on all radio broadcast receivers manufactured and sold by defendant and for certain minimum annual royalties; . . ."

(b) Further proof is found in the affidavit of John R. Binns accompanying said motion, which states at page 5:

". . . that licensees under licenses of the form of said 1937 agreement and of the form of said current license agreement have reported and paid royalties on the basis of all broadcast receivers manufactured and sold by them without raising with plaintiff or its predecessor any question as to whether such receivers embodied any one or more, or none, of the several hundred patents under which the license was granted."

(c) It is further proved by further reference to the license agreement, which provides in Article VI, Section 2, on page 10, that defendant will mark on its sets all of the Hazeltine patents which are "in the opinion of Licensor, involved in apparatus of the types licensed hereunder manufactured by one or more licensees of Licensor." Under Section 3 of said Article VI, pages 10 and 11, of said agreement, defendant was required to submit all of its models to plaintiff for such patent markings and was prohibited from the release of said models for sale until the requirements of the section had been complied with.

5. Said license agreement provides in Article VI, Section 2, page 10, that apparatus sold by defendant which does not bear the patent marking notice of Hazeltine patents as required by the agreement, "is not licensed". Defendant has, therefore, not sold any apparatus under its license from Hazeltine as it has not applied any Hazeltine patent markings to any apparatus it has sold since September 1, 1942, the effective date of said agreement. Defendant is, therefore, not subject to the payment of any royalties to Hazeltine under said license agreement.

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6. (a) Said license agreement contains in Article VIII, Section 1, page 11, the following provision:

> "Section 1. Licensor agrees that it will bring and diligently prosecute such suits for infringement of the various patents under which licenses are herein granted as may in its judgment be reasonably necessary and prudent for enforcing those patents and preventing unlicensed competition in patented apparatus in the field of this license."

(b) Said provision is a vital portion of said agreement, and goes to the essence thereof, for the reason that the manufacture and sale of radio receivers is a highly competitive business and defendant cannot compete in the manufacture and sale of such receivers if it is compelled to pay royalties which its competitors do not have to pay. The royalties which defendant would be compelled to pay plaintiff for the years 1946 and 1947, if defendant were compelled to pay plaintiff Ten Thousand Dollars as royalties for each of those years, would amount to more than twenty-five per cent (25%) of defendant's net profits.

(c) Said license agreement was entered into by Hazeltine with no intention whatever of complying with the terms of said Article VIII, Section 1. On the contrary, said section was being breached by Hazeltine at the time said license agreement was signed, and has been continuously breached since that time. Indeed, Hazeltine has not only failed to prosecute infringers diligently, but it has diligently attempted to avoid prosecution of infringers, as is indicated by the following history.

(d) The following companies have made and sold radio receiving sets without paying any royalties to Hazeltine from approximately the dates placed after the name of each:

Colonial Radio Company	1927
Detrola Radio Corporation	1930
Emerson Radio & Phonograph Corporation (formerly Emerson Television-Radio Co.)	1932

Sonora Radio Corporation	1935
Motorola Radio Company	1935
General Motors Corporation	1937
The Crosley Corporation	1939
Admiral Radio Company	1939
Philco Products Corporation	1945
DeWald Radio Manufacturing Corporation	1945
Noblitt-Sparks Radio Company	June 30, 1947
Stromberg-Carlson Company	June 30, 1947
Wells-Gardner Radio Company	June 30, 1947
Wilcox-Gay Radio Company	June 30, 1947

(e) In all of the twenty years that radio companies have been operating without paying Hazeltine any royalties, only the following Hazeltine patents have been adjudicated by Hazeltine, and in every case the patents have been held invalid or not infringed, or both:

Hazeltine	1,648,808	
Thompson	1,710,035	
Hazeltine	1,755,114	
Hazeltine	1,755,115	
Wheeler	1,879,863	(Re. 19,744)
MacDonald	1,913,604	
Wheeler	1,951,685	
MacDonald	2,022,514	
Wheeler	2,041,273	
Trube	2,111,483	—

a total of ten patents in twenty years, or one patent every two years. The adjudication of ten patents in twenty years, during most of which period large companies were paying no royalties, does not constitute the diligent prosecution of such suits for infringement as would, in the judgment of Hazeltine, be reasonably necessary and prudent for enforcing its patents and preventing unlicensed competition. On the contrary, although unlicensed

competition has grown steadily through the years, Hazeltine brought only the bare minimum of suits necessary to convince those companies which had Hazeltine licenses that they would be subjected to very expensive law suits and that their customers would be subjected to harassment and intimidation if they failed to remain Hazeltine licensees and pay royalties on all sets sold. The cost of such law suits to Hazeltine licensees is indicated in the next section hereof.

(f) That Hazeltine has been diligently attempting to avoid prosecuting suits for infringement of its patents is proved conclusively by its actions with respect to Emerson and Crosley as follows:

(g) Emerson's Hazeltine license was peremptorily cancelled by Hazeltine in about the year 1933. Upon inquiry from the president of Emerson as to the reasons for this action, he was informed by Hazeltine that it was preparing a new license agreement for him to sign and which he would be permitted to sign in a few days, and that by signing the new license agreement when presented, his company would be permitted to remain in the radio business. Emerson refused to submit to such arbitrary and oppressive action, and refused to sign the new license. Emerson was thereupon sued for infringement of Wheeler patent 1,879,863 (the original of Reissue 19,744) in the Eastern District of New York, the patent being held invalid at 7 F. Supp. 908; affirmed on appeal at 79 Fed. (2d) 329.

(h) Emerson was later sued by Hazeltine for infringement of Thompson patent 1,710,035, which patent was held not infringed at 41 F. Supp. 800, and held invalid and not infringed on appeal to the Court of Appeals for the Second Circuit at 129 Fed. (2d) 580.

(i) Crosley's Hazeltine license expired at the end of 1939 and was not renewed. Crosley was thereupon sued by Hazeltine in Ohio for infringement of MacDonald 1,913,604 and 2,022,514, both patents being held not infringed by the District Court at 39 F. Supp. 775, which was affirmed on appeal at 130 Fed. (2d)

344. At the trial of that case, Mr. Laurence B. Dodds, who is the executive vice-president and trial attorney of plaintiff, made the following statement in open court, which statement is quoted from page 2 of the stenographic transcript of the trial of that case:

> "The plaintiff takes the position that defendant is using many of the plaintiff's patented inventions, but it has brought this suit on two of what we might call typical or representative of its patents in this field."

(j) Crosley and Emerson interpreted this statement by Mr. Dodds as a statement of intention on the part of Hazeltine that—

> ". . . you are going to be sued, and continue to be sued until you are out of business." *United States* v. *Hartford Empire Co.*, 46 F. Supp. 541, 580 D. C. N.D. Ohio, W.D., 1942).

(k) Crosley and Emerson thereupon, on January 13, 1941, each instituted a declaratory judgment suit against Hazeltine in Delaware, the state of incorporation of Hazeltine Corporation, (the then owner of the patents and sole owner of plaintiff in this action) Civil Actions Nos. 194 and 195, respectively, asking for a declaratory judgment of invalidity and non-infringement of all Hazeltine patents as to which they had previously been given notice of infringement but on which they had not previously been sued. Twenty (20) Hazeltine patents were named in each complaint, with a total of twenty-two patents in the two suits, as Wheeler patent 1,879,863 (Reissue 19,744) and Thompson patent 1,710,035, on which Emerson had previously been sued, were omitted from the Emerson complaint, and MacDonald patents 1,913,604 and 2,022,514, on which Crosley had previously been sued, were omitted from the Crosley complaint.

(l) Hazeltine adopted every legal tactic and procedural move the ingenuity of counsel could devise to prevent these cases from coming to trial.

(m) In the Crosley case, Hazeltine, instead of filing a compulsory counterclaim for patent infringement under Rule 13-a, first, before filing its answer, in January, 1941, filed nine suits for patent infringement against Crosley in Ohio on the same patents and failed to counterclaim against Crosley in the Delaware case on the patents involved in those Ohio suits, on the ground that the patents involved in Ohio were the "subject of a pending action" at the time its answer was filed.

(n) This necessitated a motion by Crosley in the Delaware court for an injunction restraining Hazeltine from prosecuting said Ohio suits. That motion was denied by Judge Nields in an opinion filed April 15, 1941 (38 F. Supp. 38), necessitating an appeal by Crosley to the Court of Appeals for the Third Circuit, which reversed Judge Nield's decision in an opinion filed September 11, 1941 (122 Fed. (2d) 925). Thereupon, Hazeltine filed a petition to the Supreme Court for certiorari to review the decision of the Court of Appeals, which petition was denied by the Supreme Court on March 2, 1942 (315 U.S. 813: rehearing denied March 30, 1942, 315 U.S. 831). Thereafter, on or about April 21, 1942—more than fifteen months after the complaint was filed—Hazeltine amended its answer to include a counterclaim for infringement of its patents by Crosley in the Delaware suit.

(o) On January 4, 1943, when the trial of the two cases became imminent, Hazeltine brought a motion in each suit that all further proceedings in the case be adjourned for the duration of the war and for a period of sixty days thereafter, on the ground that Hazeltine's contribution to the war effort would be impaired by trying the case, and that fact and opinion witnesses were fully engaged in the war effort, and that Crosley and Emerson would not be affected by the adjournment. This motion was denied by Judge Kirkpatrick, but, at the request of Hazeltine, Crosley and Emerson agreed and stipulated to postpone the trial of the case until May 1, 1944, without prejudice to the rights of either party, and on the agreement that said stipulation would not be used

as a basis for or in support of any application that might be made in May, 1944 for a further adjournment.

(p) On February 18, 1944, Hazeltine made another motion that the trial of the cases be postponed until May 1, 1945—again basing this motion on the war, despite the fact that Hazeltine was filing new patent applications at that time at the rate of fifty or more a year. This motion was also denied by Judge Kirkpatrick, who recommended that the parties endeavor to arrange for a mutually satisfactory date for trial during the week of May 29th.

(q) Hazeltine had previously enlisted the assistance of the Navy Department in avoiding a trial on its patents. Following Judge Kirkpatrick's latest decision not to adjourn the trial, Hazeltine informed the Navy Department that the trial of the case would require the services of some sixty Hazeltine engineers for a period of six months to a year, and that it could not work on certain Navy contracts in view of the trial. This was, of course, a ridiculous overestimate. Hazeltine then actually took a large number of engineers off war work and assigned various tasks to them ostensibly in preparation for the trial. The Navy Department then requested Crosley and Emerson to postpone the trial. Crosley and Emerson then, through their counsel, offered to take over from the Navy all Hazeltine contracts and fill them diligently without interference with the war effort or with the trial. Hazeltine thereupon, in order to avoid losing its Navy contracts, and to avoid trial of its patents, offered Crosley and Emerson a complete release from all claims of past infringement by either of those companies if Crosley and Emerson would agree to dismiss their declaratory judgment suits without prejudice. This was agreed to by Crosley and Emerson, and the suits were dismissed at that time. Crosley and Emerson were each given a release by Hazeltine which releases were identical, the Crosley release reading as follows:

"This release given this 17 day of April, 1944 by Hazeltine Corporation, a corporation of Delaware (hereinafter

referred to as "Hazeltine") to the Crosley Corporation, a corporation of Ohio (hereinafter referred to as "Crosley"), witnesseth that:

"Whereas, Hazeltine has heretofore asserted certain claims against Crosley on account of alleged infringement of certain U. S. Letters Patent, owned by Hazeltine or under which Hazeltine has the right to sue for infringement, arising out of the manufacture, use and sale by Crosley of apparatus and parts thereof; and

"Whereas, Crosley has brought an action for declaratory judgment on said Letters Patent and Hazeltine has counterclaimed therein, said action being identified as Civil Action No. 194 in the United States District Court for the District of Delaware; and

"Whereas, Hazeltine and Crosley have entered into and executed an Agreement, dated April 17, 1944 to terminate the aforesaid claims of Hazeltine against Crosley and dismiss said action:

"Now, therefore, in consideration of the foregoing premises and for other good and valuable consideration, the receipt whereof is hereby acknowledged, Hazeltine does for itself, its successors and assigns, hereby release and forever fully and completely discharge Crosley and each and all of its distributors, jobbers, dealers, vendees, customers, and users, and anyone acting by or under its authority or direction, from any and all claims whatsoever by Hazeltine for infringement of any of the Letters Patent involved in the aforesaid Civil Action arising out of the manufacture, use or sale of apparatus and parts thereof manufactured and sold by Crosley prior to the date of this Release, such release and discharge including all claims for profits, damages and interest, and all costs and payments and all other charges whatsoever by reason of the manufacture, use or sale of said apparatus.

"In witness whereof, Hazeltine has caused its corporate

seal to be hereunto affixed and these presents to be signed by its proper officer this 27th day of April, 1944.

HAZELTINE CORPORATION
By (Signed) Jack Binns

Attest:
(Signed) R. M. Adams
Asst. Secretary

State of New York)
County of New York) ss:

"On this 27 day of April, nineteen hundred and forty-four, before me came Jack Binns, to me known, who being by me duly sworn, did depose and say that he resides in the City of New York; that he is the President of Hazeltine Corporation the corporation described in, and which executed, the foregoing instrument; that he knows the seal of said corporation; that the seal affixed to said instrument is such corporate seal; that it was so affixed by order of the Board of Directors of said corporation; and that he signed his name thereto by like order.

(Signed) Peggy Coyle
Notary Public."

Thus Emerson was released from all claims for alleged infringement for 11 years and Crosley for five years.

(r) After the conclusion of the war, Emerson and Crosley resumed the manufacture of radio receivers, and threats of infringement suits by Hazeltine against these companies were again made. Crosley and Emerson thereupon filed new suits for declaratory judgment against Hazeltine Corporation in Delaware, Civil Action Nos. 783 and 784, respectively, on the same patents which had been included in their previous declaratory judgment complaints, except for the ones which had expired in the meantime. Again,

Hazeltine tried every legal tactic and procedural move it could devise to prevent these suits from coming to trial.

(s) This time the declaratory judgment suits were filed on December 19, 1945. Hazeltine first brought motions to dismiss the complaints, on the ground that there was no justifiable controversy between the parties. Judge Kirkpatrick denied these motions.

(t) Thereafter, on March 28, 1946—more than three months after the complaint was filed—Hazeltine Corporation assigned the patents in suit to a wholly-owned subsidiary (Hazeltine Research, Inc., the plaintiff here) which in the meantime it had created apparently for that purpose, in a most obvious attempt to evade being required to subject its patents to judicial scrutiny and test of validity and infringement.

(u) On May 1st Hazeltine again brought motions to dismiss, on the ground that having transferred the title to the patents from itself to its *alter ego* (its wholly-owned subsidiary, Hazeltine Research, Inc.), the controversy, if it existed, was "moot" and in any event the present owner of the patent was not before the Court and therefore the case could not be proceeded with.

(v) As might be expected of a motion of this character, on the undisputed facts the motion was denied without opinion by the order of Judge Kirkpatrick, dated August 27, 1946.

(w) Thereafter, on September 30, 1946, more than nine months after the actions were started, Hazeltine filed its answers in the cases, but did not include in those answers any counterclaim for infringement as required by Rule 13-a.

(x) (Each answer started with the contemptuous statement; "Defendant, utterly repudiating any jurisdiction of the Court over the subject matter involved in this action, and reserving exception of the null and void orders of May 23, 1946, and August 27, 1946, answers the complaint: . . .")

(y) Thereafter, again, Crosley and Emerson sought to have the cases set for trial; and when their efforts seemed approaching success, again Hazeltine made a desperate effort to avoid judicial

scrutiny of its patents. It brought a motion for a separate trial on the questions of (1) whether or not there is in the case an actual controversy between the parties (the Court previously having ruled that an actual controversy *did* exist); (2) whether or not the jurisdiction of the Court could be sustained in view of Hazeltine's assignment of its patents to its *alter ego* (a newly created, wholly-owned subsidiary) more than three months after the complaint was filed (the Court previously having ruled that the jurisdiction could be sustained); and (3) whether or not the settlement agreement in the earlier declaratory judgment suits estopped Crosley and Emerson from maintaining their actions (the Court previously having ruled that it did not).

(z) Once more, as might be expected, on a motion so utterly devoid of substance or merit, Hazeltine's motions were denied without opinion.

(aa) At the oral argument on the motion for separate trial, counsel for Crosley and Emerson again asked Judge Kirkpatrick in open Court for the setting of a trial date, and was instructed to communicate with the Court about the middle of September, 1947, for the purpose of fixing a date, depending upon Court engagements and engagements of counsel.

(ab) Thereupon, Hazeltine filed in the Court of Appeals for the Third Circuit a petition for writ of mandamus and prohibition to compel Judge Kirkpatrick to grant Hazeltine's motions and deny the motions of Crosley and Emerson. This petition was denied by the unanimous Court of Appeals in an opinion filed January 7, 1948 (76 U.S.P.Q. 80). Hazeltine then obtained from the Court of Appeals an extension of time to February 21, 1948 within which to file a petition for rehearing.

(ac) Therefore, although the new declaratory judgment complaints were filed on December 9, 1945, Hazeltine has delayed for more than 26 months in filing therein any counterclaim for infringement of any of its patents and up to the present moment has not done so.

(ad) From all the foregoing it will be clear that when, in

1941, prior to the license agreement between the parties to this litigation, the opportunity presented itself to Hazeltine, through no choice of Hazeltine, to prosecute the infringement of *all* of its patents against Emerson and Crosley, as to which it had previously given those companies notices of infringement, Hazeltine immediately thereupon, and continuously thereafter, has, with the greatest diligence attempted to avoid such prosecution, and even went to the extreme of giving Emerson and Crosley each a complete release from all claims of past infringement in 1944 in order to avoid the trial of its patents. Since the war, and continuously up to the present time, Hazeltine has continued its desperate attempts to avoid prosecution of alleged infringement of its patents by Emerson and Crosley.

(ae) It will, therefore, be evident that Article VIII, Section 1, of the license agreement between the parties to this action was breached by Hazeltine in its inception and has continuously been breached since that time.

7. (a) All Hazeltine's patents, numbering some five hundred or more, are invalid, or have no valid application to defendant's sets. In Section 6 (e) of this affidavit I listed all of the patents Hazeltine has sued on which have been held invalid or not infringed, or both, by the courts. These patents have been admitted by Hazeltine to be the best patents it owns. Since its best patents are invalid, it necessarily follows that the remainder of its patents are invalid. The admission that the patents which had been held invalid or not infringed by the courts are the best patents Hazeltine owns, is found in the statement of Mr. Laurence B. Dodds, executive vice-president and trial attorney for plaintiff, made in open court at the trial of the cases of *Hazeltine Corporation* v. *General Motors Corporation*, in Michigan, Civil Action Nos. 2426 and 2436, at 72 F. Supp. 138—which statement is quoted, as follows, from the stenographic transcript of the trial of that case, from pages 1167 to 1169:

> "Now, contrary to your Honor's impression, *it is not the weak patents which get to the court, it is the strong patents,*

and the reason for that is economics. We cannot afford, because it is economically unsound, to bring an infringement action on a minor patent. Each of these patents which has been stricken down enjoyed the prima facie validity of a grant by the Patent Office. Each was evaluated by our patent counsel highly enough to risk *an expensive infringement litigation, which we have found runs in excess of $100,000 per case.* . . .

"Now, it has been testified that we own about 450 patents. Of these somewhat less than 100 are in use, and of those *only a handful are of the importance of the patents which we have here in suit.*

"Now, the rest of that 450 patents represent various types of developments. They were inventions which were ahead of their time or inventions along lines which the art did not follow. And I cite one example:

"Just prior to the war, a large part of our research appropriation was directed towards *television.* As a matter of fact, *about 80 per cent of it.* At that time there was a battle raging among authorities as to whether television would be standardized with negative modulation or positive modulation; those two types are quite different systems, and required different types of apparatus. It was necessary for us, therefore, to carry along parallel developments in both types.

"What actually happened was Great Britain standardized on positive modulation and the Federal Communication Commission in this country standardized on negative modulation, with the result that the work we did on positive modulation was a complete nullity, at least as far as this country is concerned." (emphasis added)

(b) Furthermore, Mr. Dodds informed Mr. David Housman, president of the defendant, in Boston, in my presence, after the

filing of the complaint herein, at a conference called to settle this case, and on July 22, 1947, that Hazeltine had nothing to offer its licensees except escape from litigation and that if defendant would pay the royalties demanded by Hazeltine, defendant would have the opportunity to devote its time to its business rather than to defending law suits.

8. (a) Hazeltine has misused its patents in entering the final decree against defendant in the action in the Superior Court of Suffolk County, Massachusetts, which final decree is Exhibit B attached to Mr. Binn's affidavit.

(b) It has also misused its patents by refusing to grant licenses under any one or more of its patents to anyone who refused to take a license under all of its patents. This has been the admitted policy of Hazeltine, which policy has been euphemistically stated by Hazeltine to be that it would issue a license under any one patent to anyone who asked for it, but he would be charged full royalties therefor the same as the royalties under all of its patents, and a license under the remainder of its patents would be thrown in without extra charge. Such a refusal obviously requires the payment of royalties under invalid patents by one who wants a license under a particular patent and who is, by the license under all of the patents, estopped to deny the validity of any of them, and is clearly a misuse of patents such as to prevent enforcement of all Hazeltine patents.

(c) Hazeltine has also misused its patents by requiring its licensees to mark Hazeltine patent numbers on their sets, regardless of whether they were invalid or had no application to said sets, as required in Article VI, of its license agreement (Exhibit A attached to the complaint). Hazeltine's post-war patent marking notice contains the following patent numbers, all of which have been held by the courts to be invalid or not infringed:

Thompson	1,710,035
Hazeltine	1,755,114
Hazeltine	1,755,115
Wheeler	Re.19,744 (reissue of 1,879,863)

MacDonald	1,913,604
Wheeler	1,951,685
MacDonald	2,022,514
Wheeler	2,041,273
Trube	2,111,483

These are all the Hazeltine patents which have been held by the courts to be invalid, or not infringed, or both, except those which have expired. Wheeler, Reissue 19,744 has been held invalid by the Supreme Court of the United States, and Trube 2,111,483 has been held invalid in two circuits, the third and the seventh.

(d) Hazeltine has also misused its patents by requiring its licensees to place on their sets a restrictive notice as to the use of the sets, as required by Article VI, Section 2, page 10, of its license agreement, said notice reading as follows—as quoted from the license agreement:

> "Section 2. Licensee agrees to mark all licensed apparatus manufactured and sold by Licensee hereunder, in readily legible form, with the statement 'Licensed by Hazeltine Corporation only for use in homes, for educational purposes, and for private, non-commercial use, under one or more of the following patents and under pending applications:' followed by the word 'Patent' and the numbers of the patents which are, in the opinion of Licensor, involved in apparatus of the types licensed hereunder manufactured by one or more licensees of Licensor. The marking required by this section shall be affixed to said licensed apparatus by attaching plates bearing the required marking or by affixing said marking on said apparatus in some other form equally permanent and apparatus not bearing such marking is not licensed."

(e) Hazeltine has also misused its patents by using them to force infringers of its neutrodyne patents issued to Professor Hazeltine Nos. 1,450,080, 1,489,228, and 1,533,858 to assign their patents to Hazeltine or to grant Hazeltine, without charge, the right to grant licenses under such patents. Said infringers who

have been so required to transfer their patent rights to Hazeltine are the following:

Latour Corporation
Atwater-Kent Manufacturing Company
Zenith Radio Corporation
United American Bosch Corporation
Arthur Atwater-Kent;

and the patent rights thus coercively acquired by Hazeltine are listed in the license agreement at pages 26 to 34.

(f) Each of said companies and the individual had been sued by Hazeltine for infringement of its Hazeltine neutrodyne patents and had been held to infringe one or more of said patents. Hazeltine enforced as a condition of the settlement with those companies and the individual the royalties required by Hazeltine from all of its licensees, and, in addition thereto, the transfer to Hazeltine of the rights enumerated on pages 26 to 34 of the license agreement.

(g) References to opinions against some of those companies are as follows:

Hazeltine Corporation v. *Zenith Radio Corporation,* 100 Fed. (2d) 10, C.C.A. 7, 1938

Hazeltine Corporation v. *Atwater Kent Mfg. Co.,* 34 Fed. (2d) 50, D.C. E.D. Pa., 1929.

(h) An example of the type of coercion used is reported in the case of *Hazeltine Corporation* v. *Atwater-Kent Mfg. Co.,* 34 Fed. (2d) 50, in which Hazeltine simultaneously brought twenty-six suits against customers of Atwater-Kent Mfg. Co.

(i) Hazeltine has also misused its patents by assembling into its own hands a vast accumulation of radio patents, unused by Hazeltine, and by threatening to conduct an unlimited number of expensive law suits on said patents against anyone who refused to take a license thereunder, thereby creating a patent monopoly the whole of which is greater than the sum of its parts

and enforcing the payment of royalties on patents which are invalid or which are not used by Hazeltine or anyone else.

(j) Hazeltine has also misused its patents by requiring its licensees to sign license agreements which are so oppressive in their terms as to be contrary to public policy and void. The license agreement, Exhibit A, attached to the complaint, is an example of this.

(k) Hazeltine has also misused its patents by requiring its licensees to pay royalties on all sets sold by them whether or not said sets employ the inventions of any of Hazeltine's patents and whether or not said patents are invalid. See Section 4 hereof.

(l) Hazeltine has also misused its patents by suing and threatening to sue and otherwise harassing customers of radio manufacturing companies refusing to take licenses under its patents and coercing radio manufacturers to take licenses under its patents by threats of repeated expensive law suits. Reference is made to section 7 of this affidavit in this connection.

(m) Hazeltine has also misused its patents by forcing and attempting to force its licensees to pay royalties on radio tubes purchased by them from the Radio Corporation of America, which company has a license from Hazeltine to make and sell tubes under Hazeltine's patents and which tubes were therefore freed from said patents at the time of their purchase, thereby enforcing or attempting to enforce the payment of royalties on unpatented tubes. Reference is made to paragraph 13(b) hereof in this connection.

9. The Hazeltine license is invalid and unenforceable because it is so onerous and oppressive in its terms as to be contrary to public policy, in the following respects:

(a) It requires the licensee to manufacture only at a specified place, and not elsewhere (Article III, Section 1, page 4);

(b) It licenses the manufacturers of parts but prohibits the sale of parts under license except for bona fide repair and replacement of parts (Article III, Section 1, page 4);

(c) It requires the licensee to mark sets sold with an illegal restrictive notice stating that the set is licensed only for use in homes, use for educational purposes, and private non-commercial use (Article III, Section 2, page 4); thus attempting to compel the purchasing public to purchase additional, unnecessary radio receivers for various uses.

(d) It requires the payment of royalties on all sets, whether or not they employ the invention of any Hazeltine patent and whether or not those patents are valid (Article IV, Section 1, page 5; Section 4 of this affidavit);

(e) It permits discriminatory smaller royalties by large companies than are required from small companies (Article IV, Section 5, (a), page 7, and Article X, Sections 3, page 13);

(f) It requires the licensee to use only a particular trade mark and prohibits it from adopting a new trade mark should it so desire (Article VI, Section 1, page 10);

(g) It requires the licensee to mark on its sets all patents which "in the opinion of Licensor (Hazeltine)", apply thereto or to apparatus of the same type manufactured by another licensee (Article VI, Section 2, page 10), despite the penalty provisions of Section 4900, R.S., for false marking;

(h) It runs for a ten year period, plus an additional three years, unless the licensee has given notice of termination six months before the end of said ten years, with no provision for cancellation or termination by the licensee (Article X, Section 1, page 12), thus extending the license and requiring the payment of royalties beyond the expiration dates of a very substantial percentage of the patents;

(i) It permits Hazeltine to terminate at any time for a variety of reasons (Article X, pages 12 and 13); and

(j) It prohibits the licensee from assigning or transferring the agreement, although permitting Hazeltine to do so (Article XI, page 13).

10. The Hazeltine license is also invalid and unenforceable for failure of consideration and for eviction. There was no consideration because Hazeltine had no valid patent rights under which it would grant licenses, and defendant has been evicted from said license by the decision of the courts holding invalid and not infringed the only patents of any possible consequence owned by Hazeltine at the time said license was entered into.

11. On September 18, 1947 defendant repudiated its license with Hazeltine and said license is, therefore, no longer in effect. Said license provides in Article XII, on page 14, that it is to be governed and interpreted in accordance with the laws of the State of New York. Under the laws of New York, a patent license agreement may be terminated by repudiation by the licensee at any time. The license provides in Article XII, that "This Agreement is to be governed by and interpreted in accordance with the laws of the State of New York. Defendant, having repudiated its license, is therefore free to challenge the validity of Hazeltine's patents in this action.

12. Defendant has used no valid patents of Hazeltine in any sets made by it at any time.

13. (a) In the affidavit of Harold A. Wheeler, attached to plaintiff's motion for summary judgment, only four patents are listed as being infringed by defendant's sets. They are the following:

Wheeler	1,951,685
"	1,958,027
"	2,015,327
"	2,041,273

Of said patents, Nos. 1,951,685 and 2,041,273 were held invalid by Judge Lederle in the case of *Hazeltine Corporation v. General Motors Corporation*, reported at 72 F. Supp. 138. An invalid patent can have no valid application and cannot be infringed by any apparatus, and said two patents have, therefore, not been infringed by defendant.

(b) Patent 1,958,027 contains nineteen claims, of which all but claims 3, 15 and 17 were disclaimed by the patentee, with the assent of Hazeltine, on September 25, 1940. Said claims were disclaimed because said Wheeler patent lost a Patent Office Interference, No. 69,386, with an application of Jerome C. Smith, which application later matured into Smith Patent No. 2,223,250 and is assigned to the Radio Corporation of America. Defendant is licensed by the Radio Corporation of America thereunder. The remaining three claims of said patent are all directed to minor detailed differences from the claims lost by Wheeler and are invalid in view of the prior invention by said Smith of the subject matter of the disclaimed claims. Moreover, said claims 3, 15 and 17 of Wheeler patent 1,958,027 define structure of a vacuum tube. Defendant buys its vacuum tubes from the Radio Corporation of America, and is licensed to use said tubes by reason of such purchase, not only from Radio Corporation, but from Hazeltine for the reason that Radio Corporation of America is licensed by Hazeltine for the manufacture and sale of tubes.

(c) Patent No. 2,015,327 contains five claims. Each of these claims is directed to a vacuum tube. Again, defendant buys its tubes from the Radio Corporation of America, and is licensed to use such tubes by reason of such purchase.

(d) Mr. Wheeler's affidavit, attached to the motion for summary judgment, states on page 4 that the oscillator modulator circuit embodied in defendant's receivers and claimed in patents 1,958,027 and 2,015,327, are features essential to the construction of current commercial radio receivers of the superheterodyne type. Claims 15 and 17 of patent 1,958,027 call for an inner screen and an outer screen within the tube; patent 2,015,327 states on page 3, line 16, that the outer screen may be omitted. Said claims therefore, clearly do not define subject matter which is "essential".

GEO. K. WOODWORTH.

Sworn to and subscribed before me this thirtieth day of January, 1948.

Margaret B. Budden,
Notary Public.

[SEAL]

DEFENDANT'S AFFIDAVITS IN OPPOSITION TO PLAINTIFF'S MOTION FOR SUMMARY JUDGMENT.

[Filed February 11, 1948.]

AFFIDAVIT OF DAVID HOUSMAN IN OPPOSITION TO PLAINTIFF'S MOTION FOR SUMMARY JUDGMENT, FILED ON OR ABOUT NOVEMBER 10, 1947.

State of Florida
County of Dade, ss.

David Housman, being first duly sworn, deposes and says as follows:

I am an officer of Automatic Radio Manufacturing Company, Inc., defendant in the above entitled cause.

When I was induced to accept the license under the patents of Hazeltine Corporation, I was primarily concerned with patents represented to me to be owned by the Hazeltine Corporation covering subject matter known by various technical names which my company desired to use in the radio receivers it manufactured and sold. The said patents were included among those listed in Schedule A attached to and forming part of the license agreement. These patents were all represented to me as outstanding with presumption of validity and presumed enforceability.

Recently in consulting additional counsel particularly familiar with patents relating to radio circuits and equipment, and particularly with the patents of Hazeltine Corporation, I found to my surprise that at the time I was induced to acquire the patent license, the principal patents with which I was concerned had been held to be invalid, which facts were not made known to me. Specifically, and having in mind that the license agreement was

executed as of September 1, 1942, I am now informed and believe that,—

Letters Patent No. 1,648,088, according to my information and belief, were held invalid on September 14, 1931, as reported in 52 F. (2) 504; and also in 79 F. (2) 238, on August 16, 1935;

Letters Patent No. 1,710,035 was held invalid on July 29, 1942, as reported in 129 F. (2) 580;

Letters Patent No. 1,755,114 was held invalid on August 16, 1935, as reported in 79 F. (2) 238;

Letters Patent No. 1,755,115 was held invalid on August 16, 1935, as reported in 79 F. (2) 238;

Letters Patent No. 1,913,604 and No. 2,022,514 were held not infringed on August 28, 1942 (130 F. (2) 344), and on petition for rehearing to the Court of Appeals for the Sixth Circuit, counsel for Hazeltine made the written statement in said petition that the effect of the decision of non-infringement was to invalidate the patents because, as limited by the court, they would be inapplicable to any practical equipment. That statement, as quoted from page 7 of the petition for rehearing, is as follows:

> "When interpreted as the Court interprets them, the MacDonald patents are of no value. The antenna system to which the Court would restrict the patents was never used by the inventor, MacDonald; has never been used in commercial radio receivers; and it is improbable that it will ever be used."

The petition for rehearing was denied.

Additionally, since the date of the agreement, the remaining Hazeltine patents of any materiality to the radio receivers that my company makes and desires to continue to make have been held invalid whereby my company has thus been effectively evicted from its license under the only patents which induced my company to accept a license. These patents are as follows:

Patent No. 1,951,685, held invalid on June 23, 1947, as reported in 72 F. Supp. 138;

Patent No. 2,041,273, held invalid on June 23, 1947, as reported in 72 F. Supp. 138.

To the best of my information and belief, the Hazeltine Corporation has not received favorable adjudication of any patents affecting or alleged to affect the radio receivers manufactured by my company.

Additionally, I learned several months ago, upon consulting with my New York counsel, that Hazeltine Corporation by its actions and by unrestrained dissemination of information has waived, with respect to all of its licensees, the minimum royalty provision of its license agreements and notoriously has never enforced said provision with respect to any of its licensees and notoriously has advised its licensees and all others interested that it would not enforce or seek to enforce that provision of its license agreements.

When I was induced to enter into the license agreement, Exhibit A, effective as of September 1, 1942, the facts that at least 35 of the patents listed in Schedules A and B, annexed to said licenses had expired and that at least 10 of the patent applications listed in said Schedules had been abandoned, were withheld from me by the representatives of Hazeltine Corporation who persuaded me to sign said license on September 17, 1942.

I am informed and believe that the radio receiving sets made by my company, the circuits of which are shown in plaintiff's Exhibits B through N, are substantially identical electrically with those made and sold by Crosley Corporation and Emerson Television-Radio, Inc. I am informed and believe that these companies did not pay royalty to Hazeltine Corporation.

The mixing tubes, so called, (modulator vacuum tubes) employed in my company's radio receiving sets, namely, IR5; 12BE6; 12SA7; 14Q7; 12SA7GT, were all purchased from the Radio Corporation of America.

I am informed and believe that the Radio Corporation of America holds a license from plaintiff for the manufacture and sale of these tubes so that by purchasing them from Radio Corporation of America my company acquires a license from plain-

tiff to use them in its circuits. My company is licensed by the Radio Corporation of America under all of the patents of the so-called radio patent pool, including those of Radio Corporation of America, General Electric Company, Western Electric Company and Westinghouse Electric and Manufacturing Company, a total of more than ten thousand patents, including Smith patent No. 2,323,250.

Shortly prior to September 30, 1947, I conferred in New York with the late Samuel E. Darby, then of counsel in this case, and, in response to his questions, gave him the facts which he considered desirable to be submitted to the court in an affidavit in support of his motion to amend defendant's answer, which motion, I am informed and believe, was filed on or about September 30, 1947.

On September 30, 1947, I executed said affidavit. The statements contained therein were based solely on recollection.

In the affidavit of John R. Binns, filed in this case on or about November 10, 1947, I find in Section (h), the allegation that Hazeltine Corporation notified its licensees that Reissue patent No. 19,744 had been held invalid. Annexed to said affidavit, as Exhibit R_1, I find a photostatic copy of a letter dated May 14, 1941 by Hazeltine Corporation to its customers to the effect that said reissue patent and also patent No. 2,111,483 had been held invalid; and also as Exh. R_2, I find a photostat of my letter of May 16, 1941 in reply to said Hazeltine Corporation letter. This correspondence had escaped my attention during my conference with my New York counsel, as aforesaid, more than six years later.

Since the effective date of said license, September 1, 1942, to wit, none of the radio apparatus made and sold by my company has been marked with the license notice required by Section 2 of Article VI of said agreement and none of my company's catalogs, circulars or price lists includes the notation "Licensed under Hazeltine Corporation Patents," as required by Section 4 of Article V of said agreement for all apparatus sold thereunder.

On September 18, 1947, Automatic Radio Manufacturing Com-

pany, Inc., sent, by registered mail, to Hazeltine Research, Inc., and Hazeltine Corporation, the following letter:

September 18, 1947

Registered Mail RRR

Hazeltine Research, Inc.
325 West Huron Street
Chicago, 10, Illinois

Hazeltine Corporation
15 Exchange Place
Jersey City, N. J.

Gentlemen:

Please be advised that at a meeting of the Board of Directors of Automatic Radio Manufacturing Company, Inc., held at its principal place of business, 122 Brookline Avenue, Boston, Massachusetts, on the 17th day of September, 1947, the Board directed me formally to advise you that this corporation has repudiated and terminated the License Agreement dated as of September 1, 1942 between said Automatic Radio Manufacturing Company, Inc. and Hazeltine Corporation of Jersey City, New Jersey, a corporation of Delaware, which Agreement is alleged to have been assigned on March 28, 1946 to Hazeltine Research, Inc., a corporation incorporated under the laws of Illinois.

Very truly yours,

Automatic Radio Manufacturing Co. Inc.
(Sgd.) David Housman
President

DH/rf

This letter was duly acknowledged by Hazeltine Research, Inc.

DAVID HOUSMAN

Subscribed and sworn to before me, this twenty-sixth day of January, 1948.

Elizabeth Vradenburg
Notary Public

Notary Public, State of Florida at
My commission expires October 5, 1951
Bonded by American Surety Co. of

[SEAL]

AFFIDAVIT OF GEORGE K. WOODWORTH IN OPPOSITION TO PLAINTIFF'S MOTION FOR SUMMARY JUDGMENT.

Commonwealth of Massachusetts,
Suffolk, ss.

George K. Woodworth, being duly sworn, deposes and says,

1. I am a member of the Massachusetts bar, and together with Meyer F. Englander, Esq., represented defendant in *Hazeltine Corporation* v. *Automatic Radio Manufacturing Company, Inc.*, Commonwealth of Massachusetts, Superior Court, Suffolk, 47,229, Eq.

2. This case involved twenty-nine (29) patents, one hundred ninety-six claims (196) and twenty-seven (27) alleged infringing models involving complicated electrical structures and circuit arrangements.

After numerous lengthy conferences with defendant's expert, I reached the conclusion that not one of said twenty-seven models included the apparatus and/or circuit arrangements of any of the claims of the twenty-nine patents specified in plaintiff's answers to defendant's interrogatories; but, nevertheless, I advised the client that the expense involved in trying the case before a master of the Superior Court, to say nothing of the subsequent proceedings before a Justice of the Superior Court and the Supreme Judicial Court, would be far beyond the means of defendant, which is a comparatively small corporation, and that, therefore, settlement should be effected, if possible.

3. At my suggestion, plaintiff's New York counsel and local counsel, and defendant's counsel, together with defendant's President, David Housman, conferred at the office of said Meyer F. Englander, the morning of September 17, 1937. Entries in my diary for September 17, 1937, show that this conference lasted two hours and that in the afternoon of that day, the same persons

conferred at the office of plaintiff's local counsel, from 2:30 p.m. to 7:30 p.m. According to my present recollection, at that afternoon conference, there was prepared the agreement, a copy of which, marked Exhibit Q, is attached to and forms a part of the affidavit of John R. Binns, accompanying the motion for summary judgment, filed herein on or about November 10, 1947.

4. After the terms of said agreement had been approved by both parties, the consent interlocutory decree, copy of which marked Exhibit P is attached to and forms a part of said affidavit of said John R. Binns, was prepared in draft form, according to my present recollection. Plaintiff's New York counsel insisted that said decree should contain the paragraph now numbered "4" whereby defendant is made to admit "the validity of all the patents owned or controlled by the plaintiff," and that twenty-seven of them therein enumerated "cover all the radio receivers of sound which the defendant has manufactured and sold since October 1, 1935 and which the defendant is now manufacturing and selling," whereas in truth and in fact, prior to the date of said consent decree, at least six of plaintiff's patents had either been held void or else limited in such manner that they were valueless for all practical purposes.

5. I objected to the inclusion of said paragraph, and was told by plaintiff's New York counsel that there would be no settlement unless said paragraph remained in the decree. No such admission of validity or infringement was contained in the agreement, Exhibit Q, aforesaid. I endorsed the consent decree at the request of defendant's President, David Housman, in spite of said objectionable paragraph "4", because of the statement made by plaintiff's New York counsel that otherwise no settlement could be effected.

6. On or about July 2, 1941, I received from the Clerk of the Superior Court for the County of Suffolk, a notice under Rule 85 of said court, reading as follows:

"Commonwealth of Massachusetts

Suffolk, SS. Superior Court

Notice Under Rule 85

George K. Woodworth, Esq.

Under the provisions of Superior Court Rules, 1932, Rule 85, a copy of which is enclosed, case No. 47229, Eq., Hazeltine Corporation vs. Automatic Radio Mfg. Co. in which you appear as counsel of record, or as a party, has been marked 'Inactive.'

(Sgd.) Thomas Dorgan Clerk"

On July 10, 1941, I received from plaintiff's local counsel, a letter dated July 9, 1941, reading as follows:

"Goldkrand & Goldkrand
Attorneys & Counsellors At Law
73 Tremont Street
Boston, Mass.

July 9, 1941

George K. Woodworth, Esq.
60 Congress Street
Boston, Mass.

Re: Hazeltine Corporation
vs: Automatic Radio Manufacturing Co.
Equity No. 47229

Dear Sir:

Because of the notice received by this office in the above entitled matter under Rule 85 our client desires that the decree which was entered on September 24, 1937, be made final.

We are, therefore, enclosing copy of proposed final decree which we shall present to the Court for allowance on Monday,

July 21, 1941, at 9:30 oclock A.M. in the Motion Session of the Suffolk Superior Court.

Very truly yours,

Goldkrand & Goldkrand
By (Sgd.) Louis Goldkrand

E

LG:EE
ENC."

The proposed final decree accompanying said letter reads as follows:

"Commonwealth of Massachusetts

Suffolk: SS

Superior Court
In Equity
No. 47229

Hazeltine Corporation
vs.
Automatic Radio Manufacturing Company

Final Decree

This cause came on to be further heard at this sitting of the Court and all parties being represented by counsel, and after hearing thereon, thereupon, upon consideration thereof, it is hereby ordered, adjudged and decreed that the decree of the Court entered in this matter on the 24th day of September, 1947, be and it is hereby made final.

By the Court,

On July 10, 1941, I replied to plaintiff's local counsel as follows:

"July 10, 1941

Louis Goldkrand, Esq.
73 Tremont Street
Boston, Massachusetts

Re: Hazeltine Corp. v. Automatic Radio, 47,229 Eq.

Dear Mr. Goldkrand:

Replying to your letter of the 9th instant, I do not object to the entry of your proposed final decree.

Very truly yours,

(Sgd.) George K. Woodworth

GKW:B"

I received from plaintiff's counsel no further notice concerning said final decree, nor any further notice of hearing on the matter.

7. On or about July 22, 1947, at the office of plaintiff's present local counsel, I was informed by plaintiff's present New York counsel that a final decree was entered in the case on December 3, 1941, and he thereupon showed me what purported to be a copy of said final decree, which was identical with the decree copy of which is attached to said affidavit of said Binns and marked Exhibit R. Prior to July 22, 1947, I had no knowledge of said final decree.

GEO. K. WOODWORTH.

Subscribed and sworn to before me, this fifth day of February, 1948.

Margaret B. Budden,
Notary Public.

[SEAL]

AFFIDAVIT OF LEO A. KELLEY IN OPPOSITION TO PLAINTIFF'S MOTION FOR SUMMARY JUDGMENT FILED ON OR ABOUT NOVEMBER 10, 1947.

State of New York,)
(ss.:
County of Queens,)

Leo A. Kelley, being first duly sworn, deposes and says:

I am a consulting engineer holding degrees in electrical engineering from the Massachusetts Institute of Technology and from Harvard University; and have since my graduation had approximately thirty years of experience in electronics. I am thoroughly familiar with radio circuits of the type used in defendant's radio receivers, as shown in Exhibits B to N, inclusive, attached to plaintiff's answers to defendant's interrogatories in this case.

I have read the affidavit of Mr. Harold A. Wheeler, dated October 27, 1947, filed in this case in support of plaintiff's motion for summary judgment and have examined the exhibits attached thereto.

Two of the patents attached to Mr. Wheeler's affidavit, Exhibits AA and BB,—namely, *Wheeler* patents Nos. 1,951,685 and 2,041,273,—were the subject of a suit for infringement brought by plaintiff's predecessor, *Hazeltine Corporation*, against *General Motors Corporation* in the United States District Court for the District of Michigan, Southern Division, which patents were held invalid by District Judge Lederle, as reported in 72 F. Supp. 138. I was retained by General Motors Corporation as its consultant in connection with the trial of that case and testified at the trial as a patent expert for General Motors. I am thoroughly familiar with the two Wheeler patents involved in that suit and with the structures made by General Motors which were accused to infringe those patents in that suit. Those General Motors sets are the same in all material respects, so far as those two Wheeler patents are concerned, as the sets now being made by defendant, as shown in plaintiff's answers to defendant's interrogatories.

Said Wheeler patents were held by Judge Lederle to be invalid

over the prior art for the reason that the patentee had "mere accomplished an old result by a combination of means whic singly, or in similar combination, were disclosed by the prior art and the patentee "had made no advance over the prior art beyon that which would be accomplished by a mechanic skilled in th art." The following prior art was before the Court:

U. S. Patents

No. 1,254,620—Newman	No. 1,675,848—Friis
" 1,282,439—Langmuir	" 1,687,245—Heising
" 1,404,573—Brillouin, et al.	" 1,709,062—Cohen
" 1,455,768—Slepian	" 1,716,573—Armstrong
" 1,574,780—Affel	" 1,736,852—Evans
" 1,611,716—Brown	" 1,869,323—Evans

Publications

"The Thermionic Vacuum Tube", by Van der Biji, 1920, pp 127–135;

"Rundfunktechnische Handbuch", Vol. 1, 1925, by Heinric Wigge, pp. 226-228 & 244-249.

The other two patents attached to Mr. Wheeler's affidavit, Ex hibits Y and Z, were *Wheeler* patents Nos. 1,958,027 and 2,015,32

Following the issuance of Wheeler patent 1,958,027, it wa in interference in the United States Patent Office with an applica tion for a patent which later issued as *Smith* patent No. 2,323,25 Upon an examination of the two patents, it will be seen that th following claims of the Wheeler patent are identical with th following claims of the Smith patent, all of which were won b Smith from Wheeler in that interference:

Wheeler	*Smith*
Claim 1 is identical with claim	9
" 2 " " " "	10
" 4 " " " "	11
" 5 " " " "	12
" 7 " " " "	14
" 8 " " " "	15

Wheeler		*Smith*
Claim	10 is identical with claim	18
"	11 " " " "	19
"	12 " " " "	20
"	13 " " " "	21
"	14 " " " "	22
"	16 " " " "	23
"	18 " " " "	24
"	19 " " " "	25

Claim 6 of Wheeler is also identical with claim 13 of Smith, except that the claim 6 of Wheeler ends with the expression, "received signal intensities" and claim 13 with "received intensities". However, in both claims, in the next to the last clause, appears the expression, "the received signal intensity". It is clear that these two claims mean exactly the same thing.

There is attached hereto a copy of said Smith patent No. 2,323,250, marked "Exhibit A".

The disclosures of Wheeler patent 1,958,027 and of said Smith patent are identical in so far as the tube structure, circuit, and operation are concerned, except in one minor detail. In the Smith patent the grid of the tube, which is used as the oscillator grid and which is marked as No. 52 in Figure 7 of the patent, has a negative bias applied to it, which negative bias is derived from a resistance numbered 62 in the cathode lead of the tube. This is one of several grid bias circuit arrangements for an oscillator tube which was well known years prior to the filing date of the application for Smith's patent.

The Wheeler patent uses a bias for the grid of the tube which is used as the oscillator grid, which bias is provided in Figure 3, for example, by the use of a grid leak resistance 26 and condenser 25. This is another of the grid bias circuit arrangements for an oscillator tube which was well known for many years prior to the filing date of either Smith or Wheeler.

There is attached hereto a chart, marked "Exhibit B", which is

entitled "Radiola 66—Patent Situation—Improved Superheterodyne Radio Receiver, Console Type", which chart, I am informed and believe, was prepared by the Radio Corporation of America and distributed to its licensees or others in or about the year 1929 to show its patent situation with respect to that receiver. That receiver is a superheterodyne receiver which is the same type receiver as those shown on Exhibits B to N attached to plaintiff's answers to defendant's interrogatories in this case.

The oscillator tube shown in that circuit diagram is the tube marked with the legend "UY-227", appearing at the lower left-hand portion of the circuit diagram. That tube and the accompanying circuit constitute an oscillator having a grid leak resistance marked with the numbers 34 and 39 in circles, and condenser which is unmarked but appears just below and to the left of figure 5, which figure is in a circle. It will be noted that the following patents appear in the chart as applying to said oscillator circuit:

No. 5—Langmuir 1,282,439, which expired in October, 1935 (Exhibit C)—Grid Leak and Condenser;

No. 46—DeForest 1,507,016, which expired in September, 1941 (Exhibit D)—Oscillation Generator.

Attached hereto is a copy of each of said patents, marked "Exhibits C and D", respectively.

The Langmuir patent 1,282,439 shows a circuit with a grid bias employing a grid leak resistance 44 and condenser 43 for the purpose of applying a negative bias to the grid of a detector tube.

DeForest patent 1,507,016 discloses, in Figure 1, for example, the circuit of an oscillation generator in which a grid leak resistance R and condenser C are used to provide a negative bias to the grid of an oscillator tube D, as in the Wheeler patent.

These patents and this chart show that it was old many years prior to the filing date of the application for the Wheeler patent 1,958,027 to use a grid leak resistance and condenser for the purpose of applying a negative bias to the grid of an oscillator tube—the only distinction between the disclosures of Wheeler and Smith.

It will be noted that all claims of Wheeler patent 1,958,027 have been disclaimed by Wheeler and his assignee except claims 3, 15, and 17. On examination of these three claims, as compared with the remaining claims of his patent, the only feature claimed by them which is not contained in remaining claims is that the space current in the tube is periodically reduced to zero. In this connection, Wheeler states on page 5, beginning at line 137:

> "There are a number of preferred circuit relations which improve the performance but are not essential in the circuits described herein."

Among those circuit relations is the following, page 5, beginning at line 150:

> "The average negative bias on grid 2 relative to cathode 1, which is provided by resistor 26 or 32 in Figures 3, 4, 5, 7, 8, 9, 10, 11, and 12, is preferably related to the voltage on the screen 3, to provide that the space current in the tube is substantially zero during the negative half cycles of the oscillator voltage on grid 2, that is, the space current is periodically reduced to zero."

In other words, the only feature in which the claim retained by Wheeler differs from those disclaimed is one which is not essential and is a mere matter of adjustment of the average negative bias on grid 2 relative to the voltage on screen 3.

The purpose of an oscillator tube in a superheterodyne set is to produce local oscillations within the set, which oscillations are heterodyned with (beat with) the incoming radio frequency signal wave to produce a so-called intermediate frequency. This was well known long prior to Wheeler and is shown, for example, in the patents listed on the Radiola 66 chart, as follows:

No. 60—Armstrong, 1,342,885, issued in June, 1920;
No. 8—Alexanderson, 1,465,961, issued in August, 1923;
No. 9—Alexanderson, 1,508,151, issued in September, 1924;
No. 52—Levy, 1,734,038, issued in November, 1929.

In such method of superheterodyne reception, the local oscillator in every case beats with the incoming radio frequency signal wave to produce a so-called intermediate frequency, which intermediate frequency will be present in the circuit of Wheeler patent 1,958,027 and which intermediate frequency is the same in all material respects in said Wheeler patent as in each of the superheterodyne patents referred to above, and in the circuit of the Radiola 66.

Wheeler patent 2,015,327, Exhibit Z attached to his affidavit, contains five claims. The language of these claims is directed to the structure of a vacuum tube, and the claims do not include any structure except the structure of the tube itself. The tubes shown in the exhibits attached to plaintiff's answers to defendant's interrogatories which use the structure are the following:

Exhibit B, tube marked 1R5;
" C, tube marked 12SA7GT;
" D, tube marked 12SA7GT;
" E, tube marked 12SA7;
" F, tube marked 12SA7;
" G, tube marked 12SA7;
" H, tube marked 12SA7GT;
" I, tube marked 12SA7GT;
" J, tube marked 12SA7GT;
" J', tube marked 12SA7GT;
" K, tube marked 14QT;
" L, tube marked 12SA7;
" M, tube marked 12SA7GT; and
" N, tube marked 1R5.

These tubes are especially designed for use as oscillator-modulator tubes, the use to which they are put in defendant's sets.

It will be noted that claims 3, 15, and 17 of Wheeler patent 1,958,027 are also directed almost entirely to the structure of a vacuum tube. The only elements of claims 3 and 15 which are not directed to the structure of the tube itself are the following:

Claim 3 — "a source of constant alternating voltage impressed on the interposed grid";

Claim 15 — "said grids having negative grid bias . . . the negative bias on said grid"; and

Claim 17 is dependent on Claim 15.

The structure defined in the remaining elements of the claims, that is, the tube structure defined in the claims, is the same structure as that defined in the claims of Wheeler patent 2,015,327.

The oscillator-modulator tube and circuits used by defendant in its sets is the tube and circuit described by Smith in his patent No. 2,323,250 (except for the detailed method of obtaining grid bias) and described in claims listed above as being identical with certain claims of Wheeler patent 1,958,027. The particular operating characteristics described by Wheeler in claims 3, 15, and 17 of his patent No. 1,958,027 are admittedly not essential and a mere matter of adjustment.

LEO A. KELLEY.

Sworn to and subscribed before me this ninth day of February, 1948.

Gladys K. Gilbert,
Notary Public.

Commission Expires March 30, 1948

[SEAL]

June 29, 1943. J. C. SMITH 2,323,250

SIGNALING SYSTEM

Filed Jan. 31, 1933 2 Sheets-Sheet 1

Fig.1.

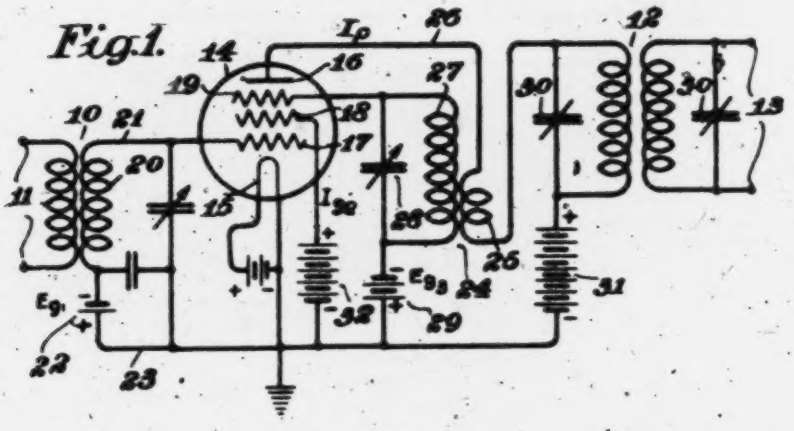


Fig.2.

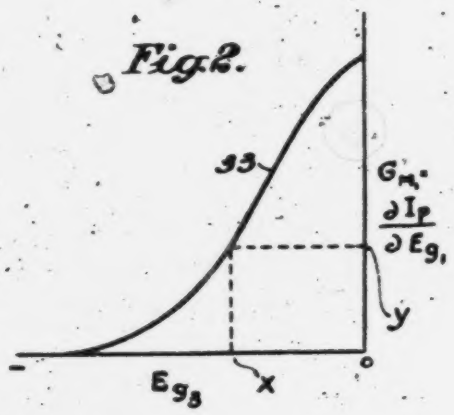


Fig.5.

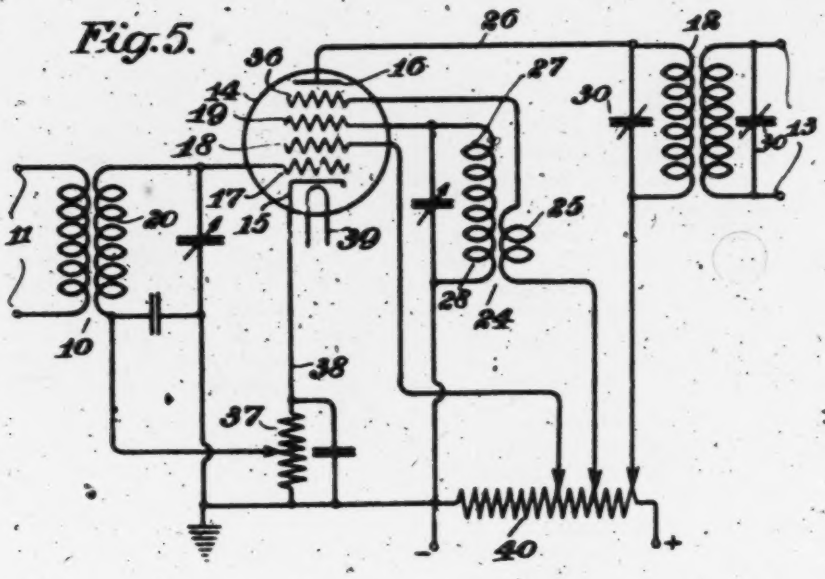


Fig.3.

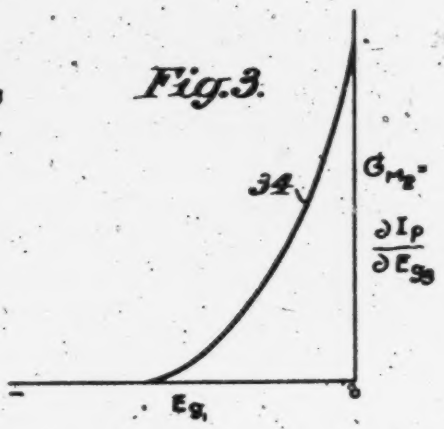


Fig.6.

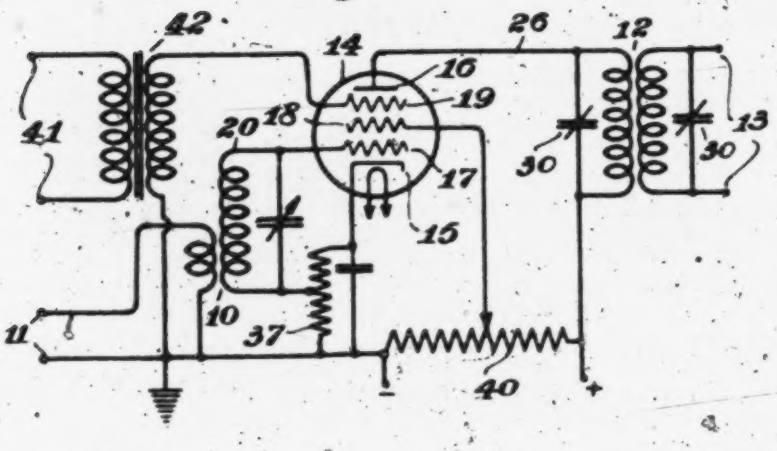
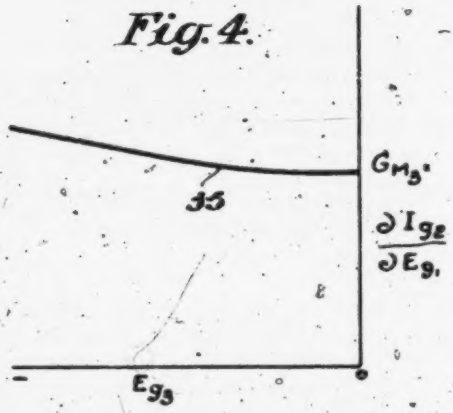


Fig.4.



INVENTOR:
Jerome C. Smith,
BY T. R. Goldsborough
HIS ATTORNEY

June 29, 1943. J. C. SMITH 2,323,250

SIGNALING SYSTEM

Filed Jan. 31, 1933 2 Sheets-Sheet 2

Fig. 7.

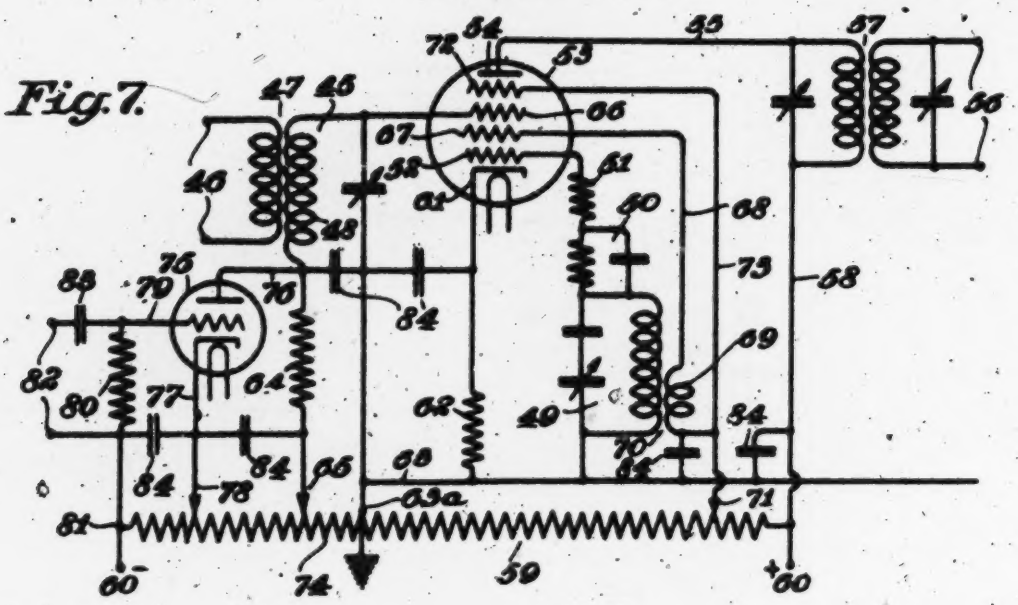
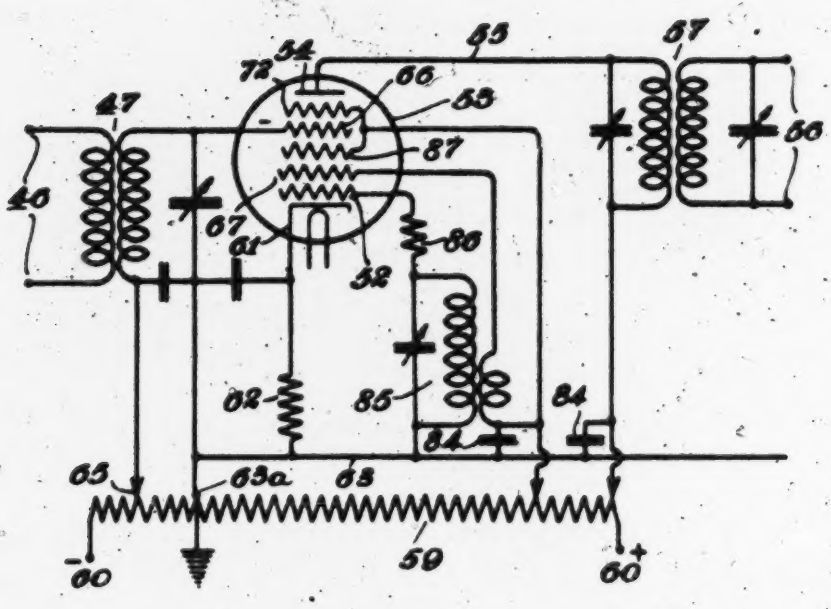


Fig. 8.



INVENTOR:
Jerome C. Smith,
BY T. R. Goldsborough
HIS ATTORNEY

Patented June 29, 1943 2,323,250

UNITED STATES PATENT OFFICE

2,323,250

SIGNALING SYSTEM

Jerome C. Smith, Merchantville, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application January 31, 1933, Serial No. 656,421

55 Claims. (Cl. 250—20)

The present invention relates to signaling systems, and more particularly to signaling systems wherein two separate signal channels are united through a suitable mixing means and provided with a common signal output channel.

Signaling systems of the above character are employed in superheterodyne receivers and the like wherein the radio signal and the oscillator signal channel are combined through a frequency changing device and applied to a common output circuit or channel in the intermediate frequency amplifier. The invention, therefore, relates more particularly to the superheterodyne type of receiving system wherein its advantages are more fully realized.

In signal channel mixing systems of the character above referred to as heretofore known, considerable difficulty has been experienced in preventing interaction between the circuits and material changes in load upon one or both of the channels leading to the common output circuit, resulting in changes in the channel gain, or in the channel frequency response characteristic, depending upon the type of transmission system employed.

It is, therefore, a primary object of the present invention to provide an improved signal transmission system embodying apparatus and methods whereby two separate signal channels may be combined and provided with a common output circuit without appreciable interaction the one upon the other, and whereby said channels function independently of each other.

It is a further object of the present invention to provide a signaling system of the above character wherein the signal amplitude in the common output circuit may be controlled without affecting certain operating characteristics of either of the input signal channels.

A further and more specific object of the present invention is to provide an improved detector-oscillator system for a heterodyne type of receiver employing a single electric discharge device as a combined detector and oscillator.

It is a still further and specific object of the invention to provide an improved signaling system wherein two signal channels are electronically coupled while being maintained electrically independent one with respect to the other.

A still further object of the present invention is to provide an improved signal transmission system wherein a single electric discharge device is employed as a mixing means between two separate signal channels and a common output signal channel and wherein the transconductance between certain of the control electrodes of the device and the anode may each be controlled by the signals to be mixed, and wherein means are provided to prevent interaction between said two electrodes and the circuits connected therewith.

A further specific object of the present invention is to provide a modulator, or modulated oscillator system, wherein two signal channels in connection therewith are prevented from interacting one upon the other to modify certain of the operating characteristics of either of said channels.

Another object of the invention is to provide a method of modulating electrical alternating current in a thermionic tube having a cathode, an anode, and an electron stream space path therebetween, which comprises attracting an electron stream to an intermediate position in said path, retarding the electron stream to form a virtual cathode at a position beyond the intermediate position, modulating the density of the virtual cathode by varying the attraction of the electron stream, further attracting a part of the stream from the virtual cathode to the anode, and causing the alternating current to vary the further attraction of said part of the stream, all in such manner that the modulation of the density of the virtual cathode thereby causes modulation of the alternating current in the vacuum tube.

Still further objects of my invention are to provide such a method in accordance with which the density of the virtual cathode is modulated by producing oscillations in the portion of the space path of the tube between the actual and the virtual cathodes to thereby vary the attraction of the electron stream in accordance with such oscillations, and the current in the output of the tube is controlled by controlling the further attraction of electrons from the virtual cathode to the anode without substantially affecting the production of oscillations in the space between the actual and virtual cathodes.

In accordance with the invention, two signal channels to be combined and provided with a common output channel are connected with two, preferably negative, control electrodes or grids of an electric discharge device which has, as other electrodes, a cathode and anode, together with positive shielding electrode means between said first named grids or electrodes and preferably between said first named electrodes and the output electrode or anode. The grids are interposed in the electronic stream between the cathode and anode in series relation to each other, that is, whereby the electronic stream traverses

first the one grid and then the other, and in such a manner that variation in the potential of one of the control grids serves to vary the transconductance of the other control electrode with respect to the anode, or in other words, the gain between the other control electrode and said anode.

Stated in other words and more specifically, in accordance with the invention, two preferably negative and high input impedance grids are arranged in a common envelope of an electric discharge device to control, in series relation to each other, a common electronic stream, the grids being shielded the one from the other by another electrode, or other electrodes, at a positive potential, and said control grids being utilized to perform different functions and/or to operate at different signal frequencies.

The operation of the device may be considered to be such that there is formed between the positive electrode and the outer negative grid a cloud of electrons or a space charge, which can be considered as a virtual cathode capable of supplying electrons at a variable rate (as determined by the instantaneous potentials of the inner grid), which can then be acted upon by the outer negative grid in the usual manner, to produce the desired frequency conversion in a superheterodyne receiver for example, wherein the inner grid is the oscillator grid and the outer grid is the signal grid.

A signaling system in accordance with the invention contemplates as a signal mixing means, a multi-element electric discharge device having between its anode and cathode a plurality of grid electrodes, and it has been found that in certain specific applications, such as its application in a superheterodyne receiving system, the connection of the oscillator and signal channel to certain of the grid electrodes provides an advantage, in addition to the independent frequency operating characteristic for each of the signal channels, of permitting a change of bias potential of one of the controlled grids to control the signal output through a common anode output circuit, also independently of the operating characteristics of the input signal channels.

By way of example, it has been found that a multi grid electric discharge device or tube may be arranged as above described, to function as a combined detector and oscillator in a superheterodyne receiver while permitting negative bias for one of the control grids to be varied, thereby to control the volume or amplitude of the signal output therefrom without appreciably affecting the average signal amplitude or frequency response characteristic of the oscillator portion of the system. With this arrangement, the control grid may be controlled manually or may be connected with an automatic volume control circuit in substantially the same manner as any other electric discharge device in the system to be controlled automatically in response to changes in the signal amplitude.

Likewise, it has been found that a radio frequency signal applied to a mixing device of the type above described through one of the input channels may effectively be modulated by audio frequency signals supplied through another input channel, without interaction between the two channels and with a relatively high gain.

In a superheterodyne receiver, a system of this character has the further advantage that the oscillator may operate at a lower output voltage, the oscillator output is not coupled into the radio frequency system and only a single device or tube is required.

The invention will, however, be better understood from the following description when taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

In the drawings,

Fig. 1 is a schematic circuit diagram of a signaling system embodying the invention, being specifically a combined detector-oscillator system for a superheterodyne type of receiver;

Figs. 2, 3, and 4 are curve diagrams indicating certain operating characteristics of the system shown in Fig. 1; and

Figs. 5, 6, 7, and 8 are modifications of the system shown in Fig. 1. Like parts throughout the various figures are designated by like reference numerals.

Referring to Fig. 1, 10 is an input transformer for a radio frequency signal input channel 11, and 12 is an output transformer in an intermediate frequency signal output channel 13, between which channels is connected a combined first detector and oscillator device 14.

The device 14 is a multi element electric discharge device or tube having a source of electrons, in the form of a usual cathode 15, and an anode 16 between which, in spaced series relation, along the electronic stream, are interposed three other electrodes or grid elements 17, 18, and 19, being, respectively, a first or inner negative control grid, a screen element or grid, and a second or outer negative control grid. The first control grid 17 is connected, as indicated, with the signal or radio frequency input channel through the secondary 20 of the input transformer 10, and the grid circuit therefor, indicated at 21, is returned to the cathode 15 through a suitable source of negative biasing potential 22 and a return ground lead 23.

The second control grid 19 is connected with an input circuit coupled to the anode 16 through a coupling transformer 24 having a primary winding 25 of low impedance connected in the anode or output circuit 26 of the device, and having a secondary 27 tuned by a suitable variable capacitor 28. The tuned secondary is connected between the grid 19 and the cathode 15 through a suitable source of negative biasing potential 29 and the common return lead 23.

The intermediate frequency output transformer 12 is tuned to the intermediate frequency by suitable condensers 30 and is interposed between the intermediate frequency output circuit 13 and the anode circuit 26, the primary of the intermediate frequency output circuit being connected with the anode 16 in series with the primary 25 and a source of anode potential 31 which is in turn connected at its negative side to the cathode return lead 23, all as indicated.

The screen electrode 18 interposed between the negative control grids 17 and 19, is also operated at a positive potential from a suitable source 32, as indicated.

It will be noted that the signal input grid 17 and the second control grid 19 are operated at negative potentials, while the anode and intermediate grid are operated at positive potentials. The system thus includes an electric discharge device having an anode and a cathode, between which is an electron stream space path in which are interposed two separate, preferably negative, control grids which are separated and shielded from each other by at least one other positive electrode.

The effect of this arrangement is such that the two control grids have no interaction one upon the other and, therefore, do not serve to load the associated circuits and thus vary the frequency response characteristic or amplitude of signals applied to the device or tube 16 through either the transformer 18 and the radio frequency signal channel 11 or the transformer 26. In this sense the control grids 17 and 19 act as two impedance controlling elements for independently varying the impedance presented to the electron stream between the cathode 16 and the anode 18.

In the present example, through the intercoupling of the anode and the electrode 19 through the tuned transformer 24, the grid 19 may be caused to operate as an oscillator at any suitable frequency within the tuning range of the condenser 28 and secondary 27. In a superheterodyne receiver, this frequency is ordinarily such that, combined with the input signals, by the electron coupling in the tube, it will cause an intermediate or beat frequency, equal to the difference between the oscillation and incoming signal frequencies, to be delivered to the output circuit or output or intermediate frequency channel represented by the terminals 13.

The control grids 17 and 19 operate preferably on a linear portion of their anode-current, grid-bias characteristic curve and are spaced with respect to each other and the anode 16 common to them so that the transconductance from each of them to the anode are of values such that the one grid, which is the grid 17 in the present example, may be utilized to receive radio frequency signals, while the other grid, which is the grid 19 in the present example, may be utilized to obtain oscillations.

The relation of the transconductances and the effect of varying a signal potential on one control grid to vary the transconductance or mutual conductance between the other control grid and the anode may be more clearly understood by referring to the curves indicated in Figs. 2, 3 and 4. In each of these curves the transconductance or mutual conductance is represented as the ordinate and the variation in grid bias potential on one of the control grids is indicated as the abscissa.

Referring to Fig. 2 particularly, there is shown the transconductance G_{m1} between the anode current I_p and the signal potential E_{g1} on the first grid 17 as the potential E_{g3} on the third or other control grid is varied as indicated by the curve 33; a potential X, for example, applied to the third grid 19, producing a mutual conductance Y between the potential on the first grid 17 and the anode 16.

In a like manner, the curve 34 in Fig. 3 represents the mutual conductance G_{m3} between the anode current I_p and the signal potential E_{g3} on the third grid 19, as the potential E_{g1} on the first grid 17 is varied.

From a consideration of these two curves 33 and 34 above, it will be seen that the combined effect of two signals applied to the control grids 17 and 19 will appear in the output circuit connected with the anode 16. However, from a consideration of Fig. 4, wherein the mutual conductance G_{m2} between the grid current I_{g2} of the second grid or shield 18 and the signal potential E_{g1} applied to the first grid 17, for example, is varied in accordance with changes in the potential E_{g3} applied to the third grid 19, we see that the mutual conductance curve 37 is substantially a straight line, indicating that there is substantially no interaction between the screen and the signal applied to the third grid 19.

From a further consideration of the curves shown in Figs. 2, 3 and 4, and the foregoing description, it will be seen that the current flow through the second grid or electrode is substantially constant with respect to variations in the potential applied to the control grid 19. The second grid may, therefore, not only serve as a screen between the two negative control grids or electrodes, but it may also serve as an anode in circuits wherein its substantially constant anode current may be utilized to advantage. Such circuits will hereinafter be described.

From the foregoing description it will be seen that the two, high impedance, negative, signal input grids are shielded from each other by a positive electrode interposed between them in a common envelope, and that the two control grids operate to control the electronic stream between the anode and cathode in series, so that the variation in potential of one negative grid controls the transconductance of the other negative grid with respect to the anode and thereby, in effect, controls the gain between the other control grid and said anode.

Stated in other words, the signal applied to one control grid serves to control the gain through the electric discharge device from the other grid, and since each grid, in effect, forms a terminal means for a separate signal channel, the signals transmitted through said channels to said grids are thus effectively united or mixed and transferred to the output circuit. In the present example, the oscillator grid and the signal grid receive signals at such differing frequencies that the resulting signal delivered to the output or intermediate frequency circuit 13 is at the desired intermediate frequency, the combined signals on the control grids 17 and 19 being rectified in the main anode circuit of the tube.

In certain applications of the system of Fig. 1 it is desirable to increase the anode impedance and the transconductance between the second or outer control grid 19 and the anode 16, and at the same time to remove from the output anode circuit 36 and its connection with the intermediate frequency circuit 13 the oscillator function introduced through the coupling provided through the transformer 24. To this end, the tube 16 may be provided with a fourth electrode or a screen element 39 between the anode 16 and the second control grid 19, as shown in Fig. 5 to which attention is now directed.

The electrode 39 not only provides a screen between the anode and the grid 19, but also serves as an auxiliary oscillator anode. It is coupled through the primary 25 of transformer 24 in the same manner as the anode 16 in the circuit of Fig. 1. Otherwise, except for a difference in the potential supply system, the circuits and the device 16 are identical with those of Fig. 1, as will be seen from a further inspection of Fig. 5.

It will be seen that the bias potentials for the control grids 17 and 19 are derived from a self bias source 31 in the anode return lead 30, and that the cathode 16 is provided with a heater 32. Likewise, the positive potentials for the screen elements 18 and 39 are derived from a suitable potential divider source 40. As shown, electrodes 18 and 39 are less positive than the anode 16.

By providing the transformer 24 with a low

impedance primary winding 26, the electrode 36 provides a more effective shield or screen between the anode 16 and the control electrode 19. This arrangement has the further advantage that the output circuit 26 from the anode 16 may be led directly through the output device 12 and to the utilization circuit. In apparatus having shielding, this has the advantage that the output circuit may be more completely shielded beginning directly with the anode 16.

The signaling system shown and described in connection with Fig. 1, embodying an electric discharge device having two separate control grids in series relation to each other, along an electronic stream in a common envelope, with a positive shield or screen member between them, is readily adapted by slight modification to provide an effective modulator system, as will be seen by referring to Fig. 6. The tube 14 with its positively energized anode 16, cathode 18 and inner and outer control grids 17 and 19 separated by the screen electrode 18 which electrostatically isolates them from each other is shown in connection with a modulating channel or signal input circuit having terminals 41 connected to the control grid 19 through a coupling transformer 42. The modulating channel is adapted to operate at audio frequencies, being provided with an audio frequency input transformer. However, other modulating signals may be used.

In the circuit shown in Fig. 6, the grid 19 receives signals from the modulating channel 41 as one source of electrical oscillations, while the radio frequency signals are supplied through the channel 11 from another source of electrical oscillations to the inner or first control grid 17. The combined signal, i. e., the modulated radio frequency signal, is thus supplied to the anode 16 and the output circuit 26, thence to the utilization circuit 12 through the output transformer 12 which, in this case, is tuned to the signal frequency.

In the event that the modulating signal and the input signal are of the same frequency, such as in the case that the signal channel 11 conveys a modulated intermediate frequency signal and the modulating channel 41 conveys the same intermediate frequency signal without modulation, then the output circuit will receive the audio frequency component of the modulated intermediate frequency signal. A system of the above character will hereinafter be described in connection with Fig. 8.

The circuit, therefore, does not differ fundamentally from that shown in Fig. 1. A difference is that grid 19 is not utilized to generate local oscillations, but instead is utilized to receive signals at the modulation frequency. The control effect of each control grid upon the mutual conductance between the other grid and the anode is the same as described in connection with the circuit of Fig. 1. It will, therefore, be seen that the system is readily adapted for use as a modulator, wherein the two signal channels may be operated without interaction one upon the other. Like the circuit shown in Fig. 1, the system has the advantage that modulation may be effected through the use of relatively low audio frequency modulating potentials. Also, no audio frequency power is necessary for the reason that the grid 19 is a negative, high impedance control electrode. This may be expressed in other words by stating that grid 19 is so negatively polarized or energized that substantially no current is thereby drawn from the electron discharge path during operation of the tube, including the positive half cycles of alternating current impressed on the grid 19.

It will be noted that in the above described embodiment and in the preceding embodiments of the invention, the radio frequency signal is placed upon the first or inner grid, while the modulation signal in the present example, and the oscillator signal in the preceding embodiment, is placed upon the second or outer control grid. This is a preferred arrangement, particularly in a modulator, for the reason that the lower frequency signals, such as the audio frequency modulation signals, are less effected by the anode to grid capacity than are the radio frequency signals. In other words, with the grid arrangement shown, the radio frequency signal circuit receives no appreciable change in load, whereby its operating characteristic is changed in response to variations in the potential existing in the output or anode circuit.

Referring now to Fig. 7, a combined detector-oscillator system is shown, wherein, as distinguished from the circuit arrangement of Figs. 1, 5 and 6, the connections for the signal or control grids are reversed, thereby placing the radio frequency signal on the outer or second control grid and the oscillator signal on the first or inner control grid.

In Fig. 7 a radio frequency signal circuit 45 is supplied with radio frequency signals from a channel, represented by input terminals 46, through a coupling transformer 47, the secondary 48 of which forms a part of the tuned radio frequency circuit. Locally generated oscillations for beating with the incoming signals are provided in a tuned oscillator circuit 49 which is connected through a compensated filter 50 and suppressor resistor 51 to the inner or first control grid electrode 52 of a multi grid electric discharge device or tube 53 and serves as an input circuit to the grid 52. The tube 53 is provided with an anode 54 and an output anode circuit 55 which is common to the input circuits 55 and 60 of the control grid electrodes 52 and 58 respectively and is coupled to an output or intermediate frequency signal channel, represented by terminals 56, through a tuned coupling device 57. Anode operating potential is supplied to the anode circuit 55 through a supply lead 58 connected with a suitable source of direct current 59 having supply terminals 59—59.

The cathode of the tube 53 is indicated at 61 and is connected through a self bias resistor 62 and a grounded cathode return lead 63 to an intermediate tap point 63a on the potential source 59. The polarity of the potential source 59 is indicated in the drawings, and the radio frequency input circuit is connected therewith through a coupling resistor 64 to a variable tap point 65, normally indicated as more negative than the cathode connection point 63a, whereby the output signal control grid indicated at 66 and connected with the signal input or radio frequency circuit 45 is normally maintained at a negative potential.

It will be noted that the electrode or grid 66 is the third electrode from the cathode 61 and is separated from the first electrode or control grid 52 by screen electrode or grid 67. The latter grid is connected through a supply lead 68 and the primary 69 of a transformer 70 to a variable positive tap point 71 on the potential source 59.

A fourth grid electrode or element 72 is interposed between the control grid 66 and the anode

84 and is also connected to a source of positive potential, such as the tap point 71, as indicated, through a suitable supply lead 73.

With the above described circuit arrangement it will be noted that the control grid 62 operates in conjunction with the electrode 67 and the cathode 61 to provide an oscillator which is tuned by the circuit 69 of which the transformer 70 is a part. The oscillator grid 62 receives a negative bias potential relative to cathode 61 from the self bias resistor 62, while the second electrode 67 operates at a positive potential whereby it forms the plate or anode electrode of the oscillator. It also operates as a screen between the first control grid 62 and the second control grid 66 and may be termed the first or auxiliary anode or the inner screen of the tube. The electrode 67 and the control grid 62 may also be referred to as auxiliary electrodes interposed between the cathode and the grid 66 and operating as oscillation-producing means.

The screen 67 substantially prevents interaction between the oscillator and the radio frequency portions of the system. The screening function of the electrode 67 is materially increased by maintaining the primary winding 69 in circuit with it at a relatively low impedance value only sufficient to provide the necessary electrical coupling with the tuned circuit 45. As above pointed out, the screening electrode or grid 67 functions as an anode with respect to the first grid 62 and the cathode 61, through the feed-back winding 69, for maintaining oscillations. The grid 72 functions as a screen grid adjacent to the anode 84 and may be referred to as the outer screen or shielding element.

It will be seen that in accordance with the description of the operation of the circuit of Fig. 1 in connection with Figs. 2, 3 and 4, the anode current to the electrode 67 will not vary appreciably in response to variations in the signal input potentials on grid 66, and for this reason it may be utilized as the oscillator anode, thereby to permit the operation of the device as a combined detector-oscillator.

Stated in other words, the change in transconductance from the first grid or oscillator grid 62 to the second grid or oscillator anode 67 is relatively low in response to variations in the signal control grid voltage, whereby the second electrode 67 operating at a positive potential between the signal control grid 66 and the first or inner control grid 62 may serve as a combined screen and anode.

The circuit arrangement is fundamentally the same as that of Figs. 1, 5 and 6 in that two preferably negative, high impedance, control grids or impedance controlling electrodes are interposed in the electronic stream in series relation to each other and are separated by a screen electrode or grid operating at a positive potential. However, it will be noted that the control grid connections are reversed, whereby the inner grid receives the oscillation signal, and the second control grid or third electrode receives the radio frequency signal. The radio frequency signal control grid is furthermore shielded or screened from the anode and is substantially shielded or screened from the oscillator grid. The electronic coupling, whereby the separate signal input channels are substantially independent of each other and are yet provided with a common output circuit is, otherwise, the same as described in connection with Fig. 1. The circuit described, however, has a further important advantage over any of the preceding circuits as will be seen from a further consideration of the circuit.

It will be noted that the grid bias potential applied to the signal control grid 66 is derived in part from the self bias resistor 62 and in part from a portion 74 of the potential supply source through the variable tap connection 68. The combined potentials are applied to the grid circuit 46 through the fixed resistor 64. With this arrangement the bias potential applied to the grid 66 varies with changes in the anode current through the self bias resistor 62 and may be varied manually by adjustment of the tap 68. It may also be caused to vary by varying a flow of current through the resistor 64 through the medium of any suitable means such as an automatic volume control device or tube, as will hereinafter be described.

It has been found that a variation of the biasing potential applied to the signal control grid 66 serves effectively to vary or control between desired limitations the output volume or amplitude of the beat frequency or intermediate frequency signal and that this may be done without effecting the oscillator frequency. In other words, by controlling the bias potential on the second or outer negative grid while the first or inner negative grid is employed in the oscillator, the amplification or gain through the detector-oscillator system may be controlled without impairing the oscillator voltage amplitude, stability, or frequency characteristic. While a single thermionic or electron discharge device is thus used in a signal channel mixing circuit, yet volume control means may be applied to the device and be used with the electron coupling without impairing certain desired operating characteristics of one of the coupled circuit, in this case the oscillator portion. The two separate independent functions of the control grids and the operating circuits in connection therewith are undisturbed and unaffected by the volume control arrangement.

The ability to control the volume of the signal output in connection with a device of this character in a signal system is extremely desirable, and it will be seen that an automatic volume control system may be coupled to the signal input grid to control it automatically in response to changes in the average amplitude of incoming signals.

In the present example an automatic volume control device or tube 75 is connected with the resistor 64 through its anode circuit 76. In order to place a positive potential on the anode, its cathode lead, indicated at 77, is connected to a variable tap 78 on the source 59 more negative than the tap point 68, and the grid circuit 79 is returned through a coupling resistor 80 to a still more negative point 81 also on the source 59. Controlling potentials such as radio frequency signal potentials are supplied to the coupling resistor and hence to the volume control tube from any suitable source, such as terminals indicated at 82, through a suitable coupling means or condenser 83.

With this arrangement, it will be seen that variations in the average amplitude of potentials supplied to the terminals 82 which receive signal energy from a source common to them and to input terminals 46 will cause the anode current of the device 75 to vary through the resistor 64, thereby varying the biasing potential applied to the grid 66. The present arrangement operates

in such a manner that as the signal strength increases, the anode current through circuit 76 also increases, thereby increasing the potential drop through the resistor 84 and the negative bias on the grid 66, which in turn reduces the amplitude of signal output from the output circuit 88. As hereinbefore described, this action is entirely independent of the oscillator signal set up in the circuit 49 and does not serve to vary it either in frequency or amplitude.

The filter circuit 80 and the suppressor resistor 81 in the oscillator grid circuit are for the purpose of smoothing the frequency response characteristic of the oscillator throughout the operating range, and are shown in the circuit as used. They do not, however, form any part of the present invention except incidentally in connection therewith and, accordingly, are believed to require no further description.

It will also be noted that suitable by-pass capacitors 84 are provided throughout the circuit as required, and represent well known means for preventing coupling in the supply circuits.

As fully appears from the foregoing description and the drawings, Fig. 7 shows a system responsive to electric oscillations comprising electron tube 53 having a cathode 61, grid elements 62 and 66, an anode 67 which is the first anode in the sense of being nearest to the cathode, and a second anode 64, in combination with high frequency oscillation generating means including the tuned oscillator circuit 49 and the transformer primary 69 disposed respectively between the cathode 61 and the grid 62 and between the cathode and the first anode element 67 for modulating the electron stream of the tube at a frequency determined by the oscillation generating means, means including control grid 66 for modulating the electron stream in accordance with the received electric oscillations, means including the output circuit of anode 64 for rectifying the resultant variations in the electron stream, means including tuned output circuit 87 responsive to the rectified variations and disposed in series between the cathode 61 and the second anode 64, and means in the form of screen grid 72 for shielding the portion of the electron stream of the tube between the cathode and the first anode 67 from the influence of the second anode 64 for high frequency variations of potential upon the second anode, such shielding means comprising the screen grid 72 for the second anode and a circuit between the screen grid 72 and the tuned output circuit 87 such that any portion of said last mentioned circuit which is common to the high frequency portion of the generating means is of negligible impedance at the frequency of the generated oscillations in comparison with the internal tube impedance between the cathode and the anode element 67. By-pass capacitors 84 effectively assure that any part of the circuit between shield element 72 and the anode output circuit 85, 87 and 88 which is common to any portion of the circuits of the oscillation generating means is of negligible impedance at the frequency of the generated oscillations.

Referring now to Fig. 8, a combined detector and oscillator system employing electron coupling and isolation of two signal input circuits similar to the circuit shown in Fig. 7 is further shown in connection with the electric discharge device 53. All of the circuit connections to the various electrode elements are the same and the automatic volume control connection has been omitted for simplicity of illustration. Like parts are provided with like numerals throughout. A slightly different oscillator circuit 85 and a single suppressor resistor 86 are shown in connection with the grid 62.

It will also be noted that the screen grid means 72 is provided with a second electrode portion 87, whereby it further screens the second control grid 66. The grid 72, therefore, forms a complete shield for the signal control grid 66 and it has been found in practice that this is desirable in certain circuits. It has furthermore been found that the grid or electrode 87 may be provided by a simple rod placed in the tube envelope between the first control grid and the screen 72—87 when the function of the element 87 is no longer required as a screen.

In Fig. 8, as in Fig. 7, by-pass capacitors 84 effectively assure that any part of the circuit between shield element 72 and the anode output circuit 85, 87 and 88, which is common to the circuits of the oscillation generating means is of negligible impedance at the frequency of the generated oscillations.

The embodiment of the invention shown in Fig. 8 represents the present preferred embodiment thereof and has been found in operation to give a combined detector-oscillator action without interaction between the circuits connected with the control electrodes, and a complete electronic coupling, while permitting a complete control of the output signal amplitude independently of functions of either of the signal input circuits. A circuit of this character is of importance and permits the effective use of an automatic volume control means therewith in a superheterodyne receiver, for the reason that the detector-oscillator operation is thereby rendered entirely independent of the volume control operation.

In the control of the signal output volume or output signal amplitude, it is desirable that the control grid 66 be of the exponential, i. e. variable mu, type for certain applications, whereby the volume of the signal output from the device may more accurately and effectively be controlled and whereby there is provided a very gradually changing output with varying bias voltage in the grid 66 over a wide range of output and bias voltage.

In the language of claims awarded to me in interference with the patent to Wheeler 1,958,027, there is produced in the exercise of my invention a virtual cathode composed of a cloud of electrons and acting as an electron source for anode 16 and grid 19 of Figs. 1 and 6, for anode 16 and grids 19 and 36 of Fig. 5, and for anode 64 and grids 66 and 72 of Figs. 7 and 8. This cloud of electrons may be considered in Fig. 6 by way of illustration as occupying a position on the cathode side of grid 19 and between that grid and the positive grid electrode 16. The positive potential of grid electrode 16 draws from the cathode electrons for the replenishment of the cloud of electrons constituting the virtual cathode and the retarding effect of the negative potential on control grid 19 relative to cathode 18 tends to cause the cloud of electrons to collect just beyond the electrode 18. The density of the electron supply at the virtual cathode varies in accordance with the alternating current potential impressed on the inner grid 17. When the potential on grid 17 becomes more positive an increased supply of electrons passes to the virtual cathode, and when the potential on grid 17 be-

comes more negative the electron supply at the virtual cathode is decreased. Similarly, the virtual cathode in Figs. 7 and 8 may be considered as the cloud of electrons occupying the space on the cathode side of grid 66 and between it and the next adjacent positive electrode.

I have disclosed herein a method of modulating an alternating current signal in a vacuum tube having a cathode, an anode, and an electron space path therebetween, which comprises, again with reference to Fig. 6 by way of illustration, attracting an electron stream to an intermediate position in said path as by the positively energized grid 18, retarding the electron stream to form a virtual cathode at a position beyond such intermediate position as by the negative repelling action of the negatively biased control grid 19, modulating the density of the electrons at the virtual cathode by varying the attraction of the electron stream as by impressing alternating current potential on the inner grid 17, further attracting a part of the electron stream from the virtual cathode to the positively energized anode 16 (the other part being absorbed by the positively energized grid 18), and causing the alternating current signal potential to vary the further attraction of said part of the stream as by impressing such potential on the outer control grid 19, all in such manner that the modulation of the density of the virtual cathode in turn causes modulation of the signal in the vacuum tube.

The statements made above apply in like manner to methods carried out by the arrangements shown in other figures of the drawings. In Figs. 7 and 8 the electron stream is first attracted from the cathode 61 to the intermediate position of the positively energized electrode next adjacent to and on the side of grid 66 toward the actual cathode 61. Such positively energized electrode and the negatively biased control grid 66 set up a virtual cathode between them. Figs. 7 and 8 also involve the further step of producing oscillations in the space path between the actual and virtual cathodes by varying the attraction of the electron stream, thereby effecting modulation of the density of the virtual cathode in accordance with the generated oscillations. As previously described, the oscillations are produced in the circuits associated with cathode 61 and grid electrodes 62 and 67. I also effect the further step of controlling the current in the output path associated with the main anode 64 by controlling the further attraction of electrons from the virtual cathode to the anode, without substantially affecting the oscillations in the space between the actual and virtual cathodes. As already pointed out above, in describing the tubes and circuits of Figs. 7 and 8, the production of the local oscillations between the actual cathode and the virtual cathode permits the last-mentioned step to be performed in that the production of the oscillations in the tube is not effected by the controlling potentials by which the last-mentioned step is effected. More particularly this permits use of automatic volume control means in a superheterodyne receiver for the reason that the oscillator portion of the detector-oscillator operation is substantially independent of the automatic volume control operation. In other words, variations of the negative bias on the control grid 66 do not affect the supply of electrons from cathode 61 to the oscillator electrodes 62 and 67. When, for example, signals of large amplitude are being received and grid 66 is driven strongly negative by the circuits of the automatic volume control tube 75, such negative potential on grid 66 does not prevent a plentiful supply of electrons from cathode 61 to oscillator electrodes 62 and 67 to assure maintenance of the oscillations.

The desirable features of the circuit of Fig. 8 may be utilized in a modulated oscillator by applying to the outer grid 66 a modulation signal in the same manner as shown in connection with Fig. 6. This involves merely the substitution of the input transformer 42 for the tuned circuit 45. With such an arrangement the control grids will operate at different signal frequencies and through independent input circuits, while serving to electronically couple the circuits and to provide a modulated signal output.

Furthermore, as pointed out in connection with Fig. 6, a device of the character described therein, and the modification thereof shown and described in Fig. 8 may be utilized as a detector of modulated signals, the two control grids receiving signals at the same frequency, the one being modulated and the other unmodulated.

The circuit of Fig. 8 has the additional advantage that the output volume may be adjusted by operation of the tap connection 53 as described in connection with the preceding figure. It will be appreciated, however, that any other suitable arrangement for controlling the grid bias on the signal control grid may be provided and, likewise for the oscillator or first control grid, bias means may be provided other than the self bias resistor 52. The potential sources 59 and other potential sources shown throughout the drawings in connection with the various figures, have been shown only by way of example, as representing any suitable sources of operating potential having the polarities as described.

An additional advantage of the screen grid 72 employed in the circuits of Figs. 7 and 8 lies in in the fact that it materially increases the plate impedance and the transconductance between the signal control grid 66 and the anode 64. It also tends to prevent degeneration or other interaction between said last named elements.

In a combined detector-oscillator system of the character shown and described herein, in addition to the independent operation of the electronically coupled circuits, the oscillator portion functions at a lower radio frequency voltage than was customarily used prior to my invention and in the then current superheterodyne receiver circuits employing a local oscillator tube separate from the first detector, thereby decreasing the tendency toward undesirable radiation, since only about one-tenth of the voltage output is required for the oscillator. Furthermore, a relatively high radio frequency to intermediate frequency gain is provided.

I claim as my invention:

1. In a signaling system, a multi-electrode electric discharge device having a pair of negative control grids arranged to operate in series relation to each other in the electronic stream of said device, a positive screen electrode between said grids, a signal input circuit connected with one of said control grids, a third grid, and means for coupling said third grid and the other of said control grids.

2. In a signal receiving system, a combined detector oscillator means, including in combination, a single electric discharge device having an anode, a cathode, and a plurality of grid electrodes therebetween, an oscillator circuit con-

nected with and coupling two of said electrodes more adjacent to the cathode, a signal input circuit connected with another of said electrodes, more adjacent to the anode, and a screen electrode for said signal input electrode.

3. In a signaling system, an electric discharge device having an anode, a cathode, and a plurality of grid electrodes interposed in spaced relation to each other along the electronic path between said first and second named electrodes, a signal input circuit connected with one of said electrodes more adjacent to the cathode, means for applying a negative bias potential thereto whereby it operates as a control grid, a second signal input circuit connected with another of said electrodes more adjacent to the anode, and means for applying a variable negative bias potential thereto whereby it operates as a second control grid, said control grids being separated by another of said electrodes, means for applying a positive potential to said last named electrode, and means connected with said last named electrode for feeding back energy therefrom to one of said signal input circuits.

4. In a signal receiving system, an electric discharge device having a pair of control grids, an input circuit connected with each of said control grids, an output anode circuit for said device, a screen grid interposed between said control grids, means connected with said screen grid whereby it may function as a screen electrode and as an anode, and means providing an electrical coupling between said screen grid and one of said control grids.

5. In a signal receiving system, an electric discharge device having a pair of control grids, an input circuit connected with each of said control grids, an output anode circuit for said device, a screen grid interposed between said control grids, means connected with said screen grid whereby it may function as a screen electrode and as an anode, means providing an electrical coupling between said screen grid and one of said control grids, and means for applying a variable biasing potential to the other of said control grids.

6. In a signaling system, an electric discharge device having a pair of control grids arranged to operate in series relation to each other in the electronic stream of said device, a third electrode interposed between said grids, means connected with said third electrode whereby it may function as a screen electrode between said grids and as an anode, means for applying a negative biasing potential to each of said control grids, at least one of said potentials being variable, and means for coupling said third electrode to one of said control grids for the transmission of signal potentials.

7. In a signal receiving system, a combined detector oscillator means, including in combination, a single electric discharge device having an anode, a cathode, and a plurality of grid electrodes therebetween, an oscillator circuit connected with and coupling two of said electrodes more adjacent to the cathode, a signal input circuit connected with another of said electrodes, means for applying a negative bias potential to said last named electrode whereby it operates as a control grid, and means for applying a potential to at least one other electrode adjacent to said control grid whereby said last named electrode functions as a screen for said control grid.

8. In a superheterodyne receiver, a combined detector-oscillator comprising an electric discharge device having a cathode, an anode, a signal input grid more adjacent to the anode, an oscillator grid more adjacent to the cathode, means providing a screen electrode between said grids and between said signal grid and the anode, means providing an oscillator anode between said oscillator grid and the screen electrode, a tuned oscillator coupling means between said oscillator anode and grid, a tuned signal input circuit connected with said signal input grid, means for applying a variable negative biasing potential to said signal input grid, means for applying a negative biasing potential to said oscillator grid, means for applying positive potentials to said screen electrode and oscillator anode, and an intermediate frequency output circuit connected with the anode.

9. In a modulation system, a vacuum tube comprising an actual cathode, means for producing a virtual cathode composed of a cloud of electrons, said means comprising a pair of electrodes relatively close together, the said electrode nearer said actual cathode having impressed thereon a substantially more positive voltage than the other of said electrodes, an anode near said virtual cathode, a grid between said anode and said virtual cathode, a source of signal voltage coupled to said grid, and means independent of said grid and anode for causing the electron density of said virtual cathode to fluctuate periodically and thereby modulate said signal voltage, said means comprising an electrode interposed between said actual cathode and said virtual cathode.

10. In a signal translating arrangement, an oscillator-modulator system comprising a cathode, an anode and a grid between said cathode and anode, a source of signal voltage coupled to said grid, an output circuit coupled to said anode, and oscillation-producing means for modulating said signal in said tube, said means including two auxiliary electrodes interposed between said cathode and said grid, the said auxiliary electrode furthest from said cathode having a positive voltage applied thereto, and a tuned circuit coupled between one of said auxiliary electrodes and said cathode.

11. In a signal receiving and translating arrangement, an oscillator-modulator system comprising a vacuum tube having a cathode, an anode and a first, second and third grid positioned in the space path in the order named, from said cathode to said anode, a source of positive voltage relative to said cathode impressed upon said second grid for creating an electron stream from said cathode, a signal input circuit connected between said third grid and said cathode, an output circuit connected between said cathode and said anode, and a tuned circuit connected to said cathode and coupled to said first and second grids for producing sustained oscillations.

12. In a superheterodyne receiver an oscillator-modulator system comprising a vacuum tube having an actual cathode, an anode electrode and first, second and third grid-like electrodes located at respectively increasing distances from said actual cathode in the space path between said actual cathode and said anode, a voltage source impressing a positive voltage on said second electrode, and a voltage source impressing a negative voltage on said third electrode, whereby a virtual cathode with respect to said anode is created between said second and third electrodes, a tuned circuit system connected to said actual cathode and having oscillation-producing coupling to said first and second electrodes, and

a source of signals connected between said third electrode and said actual cathode, and an output circuit connected between said cathode and an electrode located beyond said third electrode.

13. In a signal receiving and translating system, a bias controlled modulator stage comprising a vacuum tube having a cathode, an anode and at least two grids interposed between the anode and cathode, one of said grids having a variable-mu structure and having impressed thereon the signal voltage and the bias control voltage, said other grid having impressed thereon an alternating voltage, whereby space-path modulation is effected in said tube, means responsive to the output of said modulator for causing said bias voltage to automatically vary in proportion to the received signal intensity, whereby the output of said modulator stage is maintained more nearly constant than the input over a wide range of received intensities.

14. In a superheterodyne receiver, an oscillator-modulator system comprising a vacuum tube having a cathode and two oscillation-producing electrodes near said cathode, impedance means including a tuned circuit coupled between said two electrodes and connected to said cathode for producing sustained oscillations in said tube, said tube including a control grid and an anode located beyond the path between said cathode and said two oscillation-producing electrodes in said tube, a source of signal voltage coupled between said control grid and said cathode, and means for applying a bias control voltage on said control grid, whereby the anode current is controlled and any effects of the bias voltage on the oscillations are minimized by the location of said grid and anode.

15. In a superheterodyne receiver, an oscillator-modulator system comprising a vacuum tube having a cathode and two oscillation-producing electrodes near said cathode, impedance means including a tuned circuit coupled between said two electrodes for producing sustained oscillations, said tube including a control grid and an anode located in the space path beyond said oscillation-producing electrodes, a source of signal voltage coupled between said control grid and said cathode, means for developing a bias control voltage which automatically varies with the intensity of said signal source and means for applying said bias voltage to said control grid, whereby the intensity of the modulated signal in the anode circuit is maintained more nearly constant than said signal voltage over a considerable range of signal voltage at said source, without substantially affecting the intensity of said oscillations.

16. In a superheterodyne receiver, containing an oscillator-modulator system comprising a vacuum tube having an anode, an electron emitting cathode, a control electrode, a signal input circuit connected to the control electrode, means for impressing on said control electrode a bias control voltage which is negative relative to the cathode, to maintain a high tube input resistance between said signal control electrode and the cathode, and which varies automatically in accordance with the intensity of the received signals, means including a plurality of additional electrodes interposed between the cathode and the control electrode for producing local oscillations and for shielding the signal electrode from the oscillation-producing electrodes, whereby the flow of electrons to the oscillation-producing electrodes is substantially unaffected by variations in the bias control voltage and radiation of locally produced oscillations from circuits associated with the signal control electrode is prevented, and an intermediate frequency output circuit connected to the anode.

17. In a superheterodyne receiver, containing an oscillator-modulator system comprising a vacuum tube having an anode, an electron emitting cathode, a control electrode, a signal input circuit connected to the control electrode, means for impressing on said control electrode a bias control voltage which is negative relative to the cathode to cause the control electrode to act toward the signal input circuit as a high impedance electrode, means including a plurality of additional electrodes interposed between the cathode and the control electrode for producing local oscillations and for shielding the signal electrode from the oscillation-producing electrodes, whereby the flow of electrons to the oscillation-producing electrodes is substantially unaffected by variations in the bias control voltage and radiation of locally produced oscillations from circuits associated with the signal control electrode is prevented, and an intermediate frequency output circuit connected to the anode.

18. In a superheterodyne receiver, an oscillator-modulator system comprising a vacuum tube having a cathode, an anode and at least three grids located in the space path between said cathode and anode, oscillation-producing feed-back coupling between two of said grids causing sustained oscillatory currents to flow in said space path between said cathode and at least one of said two grids, a signal input circuit coupled between a third of said grids and said cathode, and an output circuit coupled to said anode, causing said oscillatory currents to modulate the signal from said input circuit, means for developing a bias voltage which becomes more negative when the signal intensity increases, and means for impressing said bias voltage on said third grid, thereby maintaining the output intensity in said output circuit more nearly constant than the input intensity over a considerable range of input signal intensities, and at the same time preventing any substantial variation of said oscillatory currents.

19. A modulation system comprising a vacuum tube having an input circuit and an output circuit, said vacuum tube having a space-current path in which are included a cathode and at least two grids, one of said grids having a source of alternating voltage connected thereto, the other of said grids having said input circuit connected thereto and having impressed thereon a variable bias voltage more negative than said cathode, said other grid being of the type giving a gradual variation of space current when said bias voltage is varied.

20. A modulation system comprising a vacuum tube having a cathode, an anode and first, second and third grid-like electrodes interposed in the space path, in the order named, from said cathode to said anode, a signal input circuit connected between said third electrode and said cathode, an output circuit connected between said cathode and said anode, a source of oscillations connected between said first electrode and said cathode, a source of positive voltage connected to said second electrode, and a source of variable negative bias voltage applied to said third electrode for controlling the output of said system, said third electrode being of the type which provides a very gradually changing output

with varying bias voltage over a wide range of output and bias voltage.

21. A modulation system comprising a vacuum tube having a cathode, an anode and first, second, third and fourth grid-like electrodes interposed in the space path, in the order named, from said cathode to said anode, a signal input circuit connected between said third electrode and said cathode, a modulated-signal output circuit connected between said cathode and said anode, a source of positive voltage applied to each of said second and fourth electrodes, a source of oscillations connected between said first electrode and said cathode, and means for applying a variable bias voltage upon said third electrode, whereby the output of said tube may be varied over a wide range.

22. Means for performing on an electric signal wave in one vacuum-tube space path the combined operations of modulation, amplification, and bias-voltage control of amplification, said means comprising a cathode, an inner grid, an inner screen, an outer grid, an outer screen and an anode, all situated in said space path in the order named, said grids having a negative average bias relative to said cathode, said screens and anode being considerably positive relative to said cathode, said inner grid and inner screen having oscillation-producing coupling therebetween, said outer grid having a signal-voltage source coupled thereto, said anode having an output circuit coupled thereto responsive to the difference between the signal and oscillation frequencies, said amplification being controlled by the outer grid bias.

23. A system having the means according to claim 22 in combination with means for causing the outer grid bias to increase automatically with increasing signal intensity, thereby maintaining the amplified signal voltage more nearly uniform than the signal voltage of said source.

24. The method of modulating a signal in a vacuum tube having a cathode, an anode and a space path therebetween, which comprises attracting an electron stream to an intermediate position in said path, retarding said stream to form a virtual cathode just beyond said position, modulating the density of the virtual cathode by varying the attraction of said stream, further attracting a part of said stream from said virtual cathode to said anode, and causing said signal to vary the further attraction of said part of said stream, the modulation of the density of the virtual cathode thereby causing modulation of the signal in said vacuum tube.

25. The method of modulating a signal in, and controlling the modulated output of, a vacuum tube having an actual cathode, an anode and a space path therebetween, which comprises attracting an electron stream to an intermediate position in said path, retarding said stream to form a virtual cathode just beyond said position, producing oscillations in the space path between said actual and virtual cathodes by varying the attraction of said stream, further attracting a part of said stream from said virtual cathode to said anode as output current, causing the signal to vary the further attraction of said part of said stream and thereby to produce in the output current path a current fluctuation of the frequency difference beween signal and oscillation, and controlling the current in said output path by controlling said further attraction without substantially affecting the oscillations in the space between said actual and virtual cathodes.

26. An electron discharge device comprising a thermionic cathode, an anode, an output circuit connected to said anode, two impedance controlling elements for independently varying the impedance presented to an electron stream between said cathode and said anode, an auxiliary anode interposed between said cathode and said first-mentioned anode, oscillation-producing means comprising circuits coupled together and connected respectively to said auxiliary anode and one of said controlling elements, and means comprising a grid-like element interposed between said two controlling elements whereby electrostatic coupling between said two controlling elements is substantially eliminated.

27. A heterodyne detector comprising an electron discharge device having a thermionic cathode, an anode, two input grids interposed between said cathode and anode and passed successively by the electron stream from said cathode to said plate, positively energized electrode between said input grids and proportioned to intercept only a fraction of the electron current from said cathode, an oscillation generating circuit connected to said cathode, said output electrode, and said input grid adjacent said cathode, a signal circuit connected to said cathode and to said other input grid, an output circuit connected to said cathode and to said plate, and a positively polarized screen between said other input grid and said output electrode connected to said oscillation generator circuit.

28. In an electrical system the combination of a continuous electron discharge path comprising an electron emitting cathode and a positively energized anode, a plurality of negatively energized electrodes spaced between said cathode and anode and electrostatically isolated from each other by an electrode interposed therebetween, a plurality of sources of oscillations, and means for impressing different ones of said oscillations upon different ones of said negatively energized electrodes, the negative energizing of a one of said electrodes between said interposed electrode and said anode being so proportioned that substantially no current is thereby drawn fom said electron discharge path during operation, whereby fidelity of operation is enhanced.

29. In anelectrical system the combination of an electronically active path comprising an electron emitting source and an appropriately spaced therefrom positively energized anode, differently spaced control electrodes interposed between said source and said anode, said control electrodes being electrostatically isolated one from the other by an electrode interposed therebetween, separate sources of electrical oscillations, separate means for impressing one of said oscillations between said electron emitting source and one of said control electrodes, separate means for impressing another one of said oscillations between said electron emitting source and a control electrode farther removed therefrom, and means for so negatively polarizing said farther removed electrode that in operation substantially no current is thereby drawn from said electronically active path, whereby fidelity of operation is enhanced.

30. In an electrical system the combination of an electron discharge path comprising an electron emitting cathode and a cooperating positively energized anode, a pair of differently spaced grid electrodes interposed in said path, said grid electrodes being electrostatically isolated one from the other by an electrode interposed therebetween, a pair of separate sources

of electrical oscillations having separate connections for separately impressing them one between said cathode and the nearer thereto one of said grid electrodes, and the other between said cathode and the farther removed therefrom grid electrode, and means for so negatively energizing at least said farther removed grid electrode that substantially no grid current is drawn thereby from said path during operation, whereby fidelity of operation is enhanced.

31. In an electrical system, the combination of an electronically active path comprising an electron emitting source and an appropriately spaced therefrom positively energized anode, differently spaced electrodes interposed between said source and said anode, an electrode between two of said interposed electrodes positively energised to a lesser degree than said anode, separate sources of electrical oscillations separate means for impressing one of said oscillations between said electron emitting source and one of said interposed electrodes located between said source and said positively energized interposed electrode, separate means for impressing another one of said oscillations between said electron emitting source and a control electrode on the far side of said positively energized interposed electrode, and means for so negatively polarizing said far side electrode that in operation substantially no current is thereby drawn from said electronically active path, whereby fidelity of operation is enhanced.

32. The method of modulating electrical alternating current in a thermionic tube having an electron emitting source, an anode and an electron stream space path therebetween, which comprises constantly attracting electrons of said stream to an intermediate position in said path, negatively repelling electron movement at a position beyond said intermediate position, modulating the density of the attracted electrons by variably polarizing that part of said electron stream subjected to said constant attraction, further attracting electrons to said anode, and causing said alternating current to vary said negative repelling of electron movement less than enough on the positive half cycles of the alternating current to draw substantially no electrons from said electron movement, whereby the fidelity of modulation is enhanced.

33. The method of modulating electrical alternating current in a thermionic tube having an electron emitting source, an anode and an electron stream space path therebetween, which comprises attracting electrons of said stream to an intermediate position in said path, negatively repelling electron movement at a position beyond said intermediate position, modulating the density of the attracted electrons by variably polarising said stream at a position ahead of said intermediate position, further attracting electrons to said anode, and causing said alternating current to vary said negative repelling of electron movement less than enough on the positive half cycles of the alternating current to draw substantially no electrons from said electron movement, whereby the fidelity of modulation is enhanced.

34. The method of modulating electrical alternating current in an electronically active path having an electron emitting source, an anode and an electron stream space path therebetween, which comprises constantly attracting a substantial part of the electrons of said stream to an intermediate position in said path, modulating the density of said constantly attracted electrons, further attracting electrons to said anode causing said alternating current to vary said further attraction, and sufficiently negatively polarizing the varying of said further attraction that substantially no electrons are drawn from said electron stream on the positive half cycles of the alternating current, whereby the fidelity of modulation is enhanced.

35. The method of modulating electrical alternating current in an electronically active path having an electron emitting source, an anode and an electron stream space path therebetween, which comprises attracting electrons of said stream to an intermediate position in said path, modulating the density of the attracted electrons by variably polarizing said stream at a position in advance of said intermediate position, further attracting electrons to said anode, causing said alternating current to vary said further attraction, and sufficiently negatively polarizing the varying of said further attraction that substantially no electrons are drawn from said electron stream on the positive half cycles of the alternating current, whereby fidelity of modulation is enhanced.

36. In a system for modulating electrical alternating current, a thermionic tube comprising an electron emitting source, a pair of electrodes relatively close together, the said electrode nearer said electron emitting source being positively energised and the other one of said electrodes being negatively energized, a positively energised anode beyond said negatively energized electrode, a source of alternating current connected to said negatively energized electrode, an electrode interposed between said electron emitting source and said pair of electrodes, and a second source of alternating current connected to said last mentioned electrode, said negatively energised electrode being sufficiently so energised that substantially no current is drawn thereby during the positive half cycle of the impressed thereon alternating current, whereby the fidelity of modulation is enhanced.

37. In a system for modulating electrical alternating current, a thermionic tube comprising an electron emitting source, a pair of negatively energized electrodes and an interposed therebetween positively energised electrode, a positively energised anode beyond said electrodes, and separate sources of alternating current connected to said negatively energised electrodes, the one of said electrodes nearer to said anode being sufficiently negatively energised that substantially no grid current is drawn thereby during operation, whereby fidelity of modulation is enhanced.

38. A system responsive to electric oscillations comprising an electron tube having cathode, grid, anode and second anode elements, high frequency oscillation generating means disposed between said cathode, grid and first mentioned anode elements for modulating the electron stream of said tube at a frequency determined by said oscillation generating means, means for modulating the electron stream in accordance with the received electric oscillations, means for rectifying the resulting variations in the electron stream, and means responsive to said rectified variations disposed in series between said second anode and cathode elements, and means for substantially shielding that portion of the electron stream of said tube between said cathode and first mentioned anode elements from the influence of said second anode element for high fre-

quency variations of potential upon said second anode, said shielding means comprising a shield element for said second anode and a circuit between said shield element and said means responsive to said rectified variations such that any portion of said last mentioned circuit which is common to the high frequency portion of said generating means is of negligible impedance at the frequency of the generated oscillations in comparison with the internal tube impedance between said cathode and first mentioned anode elements.

39. A system responsive to electric oscillations comprising an electron tube having cathode, grid, anode and second anode elements, high frequency oscillation generating means disposed between said cathode, grid and first mentioned anode elements for modulating the electron stream of said tube at a frequency determined by said oscillation generating means, means for modulating the electron stream in accordance with the received electric oscillations, means responsive to the resulting variations in said electron stream disposed in series between said second anode and cathode elements, and means for electrostatically shielding said grid element from the influence of said second anode element for high frequency variations of potential upon said second anode, said shielding means comprising a shield element for said second anode and a circuit between said shield element and said responsive means such that any portion of said last mentioned circuit which is common to the high frequency portion of said generating means is of negligible impedance at the frequency of the generated oscillations in comparison with the internal tube impedance existent between said cathode and first mentioned anode elements.

40. A system responsive to wave signaling energy comprising an electron tube having oscillation-generator-elements and at least one auxiliary element, means including said generator-elements for the self generation of oscillations by said tube and for varying the electron stream of said tube at a frequency determined by said oscillations, means for simultaneously varying said electron stream at a frequency determined by said signaling energy, means for utilizing the resulting variations in said electron stream to set up a flow of current at a third frequency in an auxiliary circuit disposed between said auxiliary element and one of said generator elements, and means comprising a shield element having a connection with said auxiliary circuit of low reactance at the frequency of said oscillations whereby the electron stream between said generator-elements is shielded electrostatically from the tube elements other than said generator elements.

41. A system responsive to wave signaling energy comprising an electron tube having oscillation-generator-elements and at least one auxiliary element, means including said generator-elements for the self generation of oscillations by said tube and for varying the electron stream of said tube at a frequency determined by said oscillations, means for simultaneously varying said electron stream at a frequency determined by said signaling energy, means for utilizing the resulting variations in said electron stream to set up a flow of current at a third frequency in an auxiliary circuit disposed between said auxiliary element and one of said generator-elements, and shielding means within said tube having a connection to said auxiliary circuit comprising a path of relatively low reactance at the frequency of said oscillations and signaling energy.

42. A system responsive to wave signaling energy comprising an electron tube including cathode, grid, anode and second anode elements positioned in the order named, circuits for the self-generation of oscillations disposed between said cathode, grid and first mentioned anode element for varying the electron stream of said tube at the frequency of said oscillations, means for varying the electron stream of said tube in accordance with the frequencies of said signaling energy, an auxiliary circuit disposed between said second anode and said cathode elements and including an output device, means for maintaining said second anode electro-positive with respect to said cathode, means for setting up a flow of current in said output device which varies at frequencies equal to the difference between the frequency of said oscillations and the frequencies of said signaling energy whereby a potential across said output device is caused to vary in accordance with said flow of current, and means for substantially electrostat cally shielding that portion of the electron stream of said tube between said cathode and first mentioned anode elements from the influence of said varying potential across said output device.

43. A system responsive to wave signaling energy comprising an electron tube including cathode, grid, anode and second anode elements, circuits for the self-generation of oscillations disposed between said cathode, grid and first mentionod anode element for varying the electron stream of said tube at the frequency of said oscillations, means for varying the electron stream of said tube in accordance with the frequencies of said wave signaling energy, a circuit disposed between said second anode and cathode elements and including an output device, means for maintaining said second anode electropositive with respect to said cathode, means for setting up a flow of current in said output device which varies at frequencies determined by the combined effect upon the electron stream of the frequency of said oscillations and the frequencies of said wave signaling energy, whereby the potential across said output device is caused to vary in accordance with said flow of current, and means for substantially electrostatically shielding that portion of the electron stream between said cathode and anode elements from the influence of said varying potential across said output device.

44. A system responsive to wave signaling energy comprising an electron tube including cathode, grid anode and second anode elements positioned in the order named, circuits for the self-generation of oscillations disposed between said cathode, grid and first mentioned anode element for varying the electron stream of said tube at the frequency of said oscillations, means for varying the electron stream of said tube in accordance with the frequencies of said signaling energy, a circuit disposed between said second anode and said cathode elements and including an output device having variable electrical constants, means for setting up a flow of current in said output device which varies at frequencies equal to the difference between the frequency of said oscillations and the frequencies of said signaling energy, and means for substantially electrostatically shielding that portion of the electron stream of said tube between said cathode

and first mentioned anode elements from the influence of said variable electrical constants of the output device.

45. In a modulation system, a vacuum tube comprising an actual cathode, means for producing a virtual cathode composed of a cloud of electrons, said means comprising a pair of electrodes relatively close together, the said electrode nearer said actual cathode having impressed thereon a substantially more positive voltage than the other of said electrodes, an anode near said virtual cathode, a grid between said anode and said virtual cathode, a source of oscillations coupled to said grid, and means independent of said grid and anode for causing the electron density of said virtual cathode to fluctuate periodically and thereby modulate said oscillations, said means comprising an electrode interposed between said actual cathode and said virtual cathode.

46. The method of modulating an oscillation in a vacuum tube having a cathode, an anode and a space path therebetween, which comprises attracting an electron stream to an intermediate position in said path, retarding said stream to form a virtual cathode just beyond said position, modulating the density of the virtual cathode by varying the attraction of said stream, further attracting a part of said stream from said virtual cathode to said anode, and causing said oscillation to vary the further attraction of said part of said stream, the modulation of the density of the virtual cathode thereby causing modulation of the oscillation in said vacuum tube.

47. The method of modulating electrical alternating current in a thermionic tube having an electron emitting source, an anode and an electron stream space path therebetween, which comprises attracting electrons of said stream to an intermediate position in said path, retarding the electron movement in said stream to form a virtual cathode just beyond said position, modulating the density of the virtual cathode by variably modifying the attraction of the electrons of said stream, further attracting electrons from said virtual cathode to said anode, and causing said alternating current to vary the further attraction of electrons, the modulation of the density of the virtual cathode thereby causing modulation of the alternating current in said tube.

48. The method of modulating electrical alternating current in a thermionic tube having an electron emitting source, an anode and an electron stream space path therebetween, which comprises attracting electrons of said stream to an intermediate position in said path, retarding the electron movement in said stream to form a virtual cathode therein, modulating the density of the virtual cathode by variably modifying the attraction of the electrons of said stream, further attracting electrons from said virtual cathode to said anode, and causing said alternating current to vary the further attraction of electrons, the modulation of the density of the virtual cathode thereby causing modulation of the alternating current in said tube.

49. In a system for modulating electrical alternating current, a thermionic tube comprising an electron emitting source, means for producing a virtual cathode composed of a cloud of electrons, said means comprising a pair of electrodes relatively close together, one of said electrodes having impressed thereon a potential positive with respect to the other one of said electrodes, a positively energized anode near said virtual cathode creating an electron stream therebetween, a source of alternating current, means for impressing the alternating potentials of said current on the electron stream between said anode and virtual cathode, and a second source of alternating current including means for impressing the alternating potentials thereof on the electron stream between said electron emitting source and said virtual cathode.

50. In a high frequency signalling system, an electron discharge tube provided with an actual cathode and an anode, means for producing a virtual cathode within the tube composed of a cloud of electrons, said means comprising a pair of grids relatively close together, means for maintaining the grid of said pair nearest the actual cathode at a substantially more positive potential than the other grid of the said pair, means for maintaining said last named grid at a substantial negative potential with respect to said actual cathode, means independent of said grids for causing the electron density of said virtual cathode to fluctuate, the last means including an auxiliary grid electrode interposed between the actual cathode and the virtual cathode, and a source of varying high frequency voltage coupled to said auxiliary grid electrode.

51. The method of modulating the output of an electron discharge tube provided with a cathode, anode and a space current path therebetween, comprising attracting an electron stream to an intermediate position in said path, retarding said stream to form a virtual cathode just beyond said position, attracting a part of said stream from said virtual cathode to said anode, and modulating the density of the virtual cathode by varying the attraction of said stream to said intermediate position and thereby causing modulation of the output of said tube.

52. In a signal reception network including a tube provided with an electron emission element an anode and a signal input electrode, a positive screen grid between the signal electrode and the anode, an auxiliary electrode adjacent the screen grid and the anode at a negative potential, said screen and negative electrode cooperating to provide a virtual cathode between the signal electrode and the anode, by virtue of a high value of said negative potential, a signal input circuit connected to the input electrode, and an output circuit connected to the anode.

53. A method of regulating the amplification of signal waves which consists in impressing the waves upon the signal grid of an amplifier tube having an effective plate current signal grid voltage characteristic whose slope is dependent upon the potential of a gain control grid, separating the signal and gain control grids by a positive screening field, and varying the bias of said gain control grid.

54. In a superheterodyne receiver, containing an oscillator-modulator system comprising a vacuum tube having an anode, an electron emitting cathode, a control electrode, a signal input circuit connected to the control electrode, means for impressing on said control electrode a bias control voltage which is negative relative to the cathode, to maintain a high tube input resistance between said signal control electrode and the cathode, and which varies automatically in accordance with the intensity of the received signals, means including a plurality of additional electrodes interposed between the cathode and the control electrode for producing local oscillations and for shielding the signal control elec-

trode from the potentials of the local oscillations produced in the tube, said last-named means utilizing one of said additional electrodes as an oscillator grid and another of said additional electrodes as a shield between the signal control electrode and the oscillator grid, whereby the flow of electrons to the oscillation-producing electrodes is substantially unaffected by variations in the bias control voltage and radiation of locally produced oscillations from circuits associated with the signal control electrode is prevented, and an intermediate frequency output circuit connected to the anode.

55. In a superheterodyne receiver, containing an oscillator-modulator system comprising a vacuum tube having an anode, an electron emitting cathode, a control electrode, a signal input circuit connected to the control electrode, means for impressing a negative bias control voltage on said signal control electrode to maintain a high tube input resistance between the signal control electrode and the cathode, shielding means interposed between the signal control electrode and the anode, means including a plurality of additional electrodes interposed between the cathode and the signal control electrode for producing local oscillations and for shielding the signal control electrode from the potentials of the local oscillations produced in the tube, said last-named means utilizing one of said additional electrodes as an oscillator grid and another of said additional electrodes as a shield between the signal control electrode and the oscillator grid, whereby the flow of electrons to the oscillation-producing electrodes is substantially unaffected by variations in the bias control voltage and radiation of locally produced oscillations from circuits associated with the signal control electrode is prevented, and an intermediate frequency output circuit connected to the anode.

JEROME C. SMITH.

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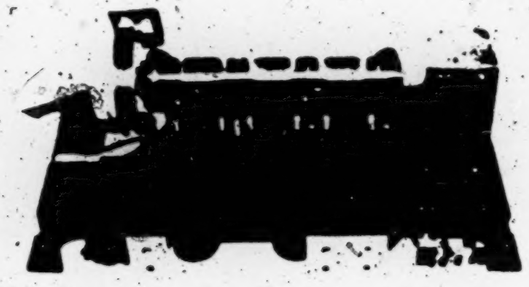
RADIOLA 66-PATENT SITUATION

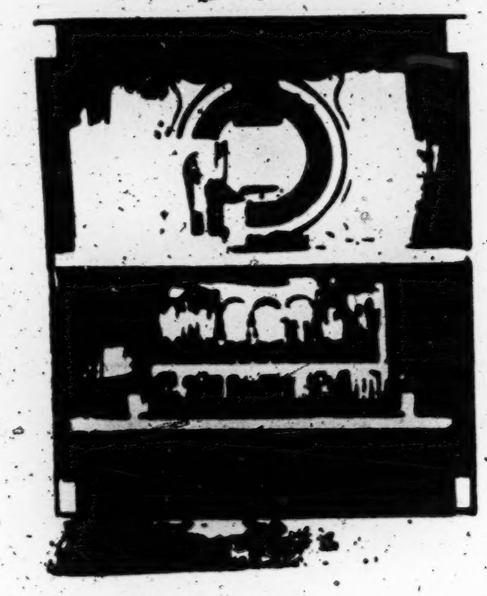
Improved Superheterodyne Radio Receiver, Console Type

(Including a socket-power unit for deriving filament, plate and bias potentials from an alternating current supply, and an electrodynamic loud speaker)

FRONT VIEW

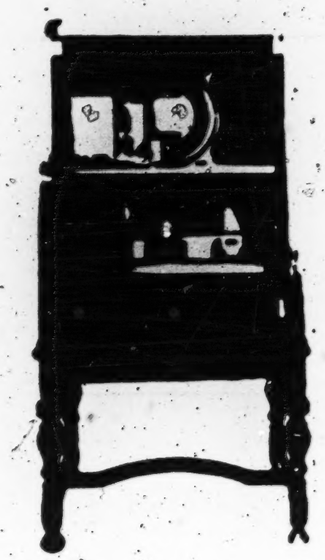


TOP VIEW of CHASSIS



ENLARGED REAR INTERIOR VIEW

BOTTOM VIEW of CHASSIS



REAR INTERIOR VIEW

Exhibit C.

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I. LANGMUIR.

SYSTEM FOR AMPLIFYING VARIABLE CURRENTS.

APPLICATION FILED OCT. 29, 1913

1,282,439.

Patented Oct. 22, 1918.

Fig. 1.

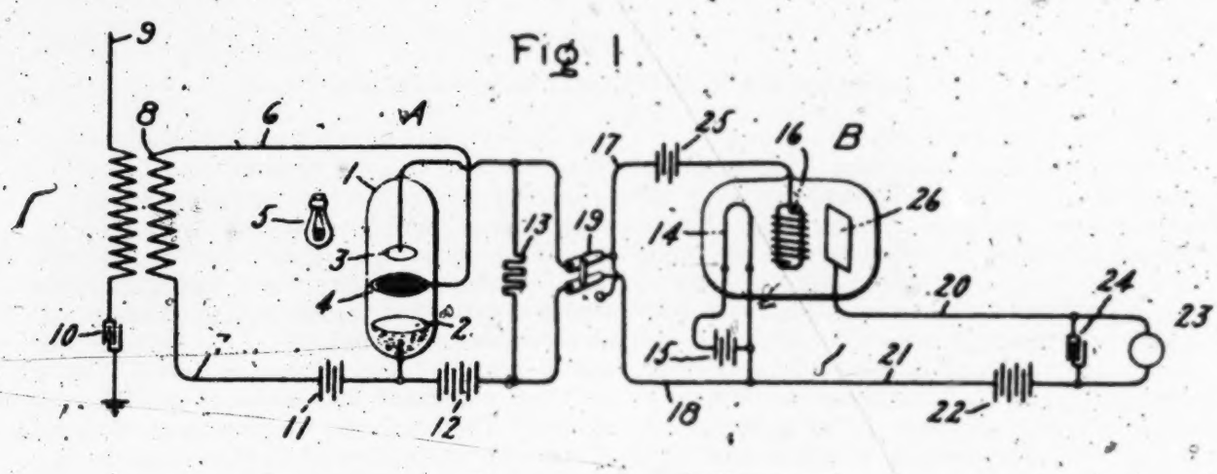


Fig. 2.

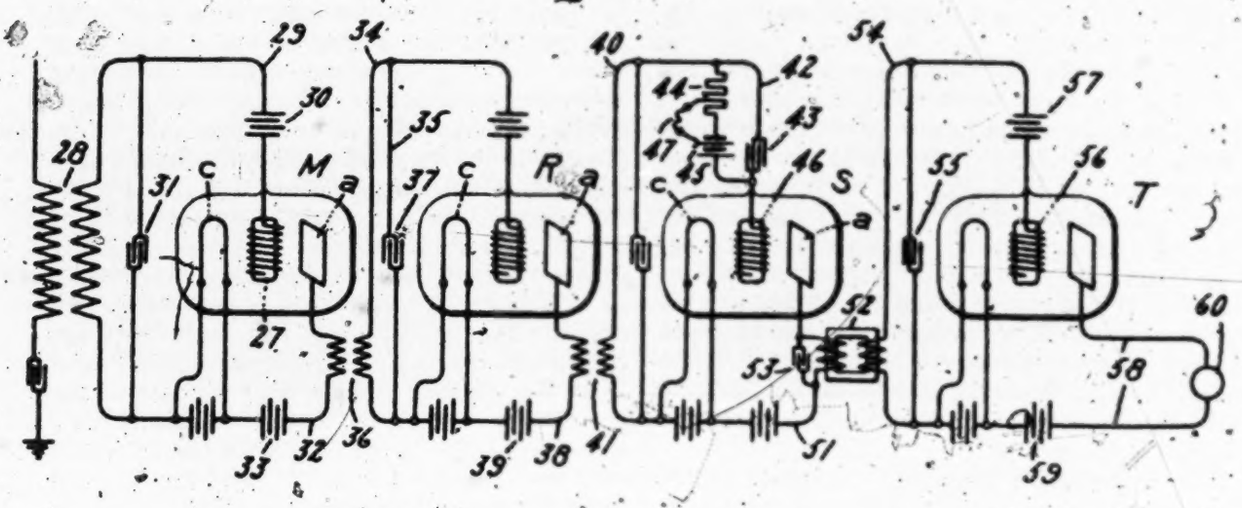
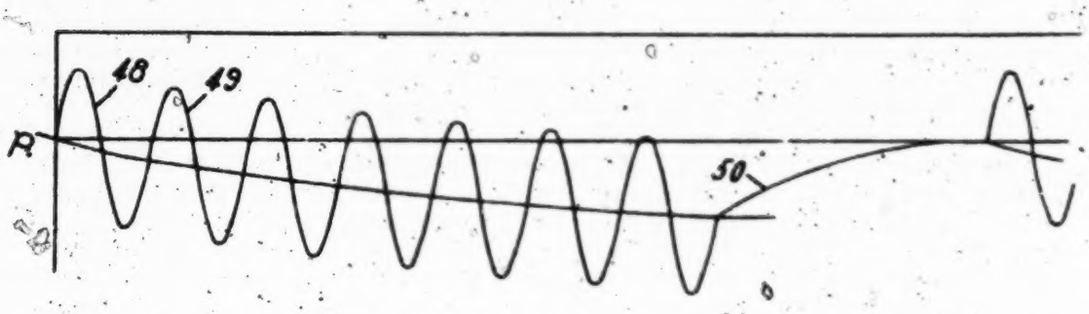


Fig. 3.



WITNESSES:

J. Earl Ryan

J. Ellis Glen.

INVENTOR:

IRVING LANGMUIR,

BY Albert G. Davis

HIS ATTORNEY.

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UNITED STATES PATENT OFFICE.

IRVING LANGMUIR, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

SYSTEM FOR AMPLIFYING VARIABLE CURRENTS.

1,282,439. Specification of Letters Patent. Patented Oct. 22, 1918.

Application filed October 30, 1913. Serial No. 797,985.

To all whom it may concern:

Be it known that I, IRVING LANGMUIR, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Systems for Amplifying Variable Currents, of which the following is a specification.

The present invention relates to electrical discharge apparatus utilizing an electron discharge and comprises novel systems of connection whereby weak variable currents may be reproduced as stronger currents. My invention also includes means for securing selectivity in detecting signals, for example, for receiving systems in radio-telegraphy.

The electron-discharge device preferably utilized in accordance with my invention comprises an incandescent, or other electron-emitting cathode, a coöperating gas-free anode and a discharge-controlling conductor, commonly called the grid, and an inclosing envelop, the space in the envelop being evacuated below the pressure at which appreciable gas ionization by collision with electrons can occur, as described and claimed in my prior application, Serial No. 795,610 filed Oct. 16, 1913, but it is to be understood that my invention is not limited to this particular apparatus.

My invention includes a combination of two or more electron discharge devices connected in cascade, the electrode circuit of one device being connected to a resistance, a reactance or transformer across which is connected the grid circuit of a second device. My invention also includes other novel features, such as means for integrating high frequency wave trains into impulses or waves of lower frequency, tuning both for group frequency as well as wave frequency, and other features pointed out with greater particularity in the appended claims.

A more detailed understanding of my invention may be had from the following description taken in connection with the accompanying drawings, which show for the purpose of illustration my invention as applied to receiving systems of wireless telegraphy. Figure 1 illustrates a system containing a device having an illuminated cathode; Fig. 2 illustrates a tuned system containing a condenser for integrating oscillations, and Fig. 3 is a diagram illustrating an integrating effect secured with a condenser with the grid circuit.

In Fig. 1 an electron discharge device A comprises a gas-tight envelop 1 which may consist of quartz or glass, preferably material pervious to ultra-violet light, and into which are sealed in the usual manner an electron-emitting cathode 2, a coöperating anode 3 and a discharge-controlling grid 4 ordinarily located between the cathode and anode. The cathode in this case consists of potassium, sodium, or other metal which emits electrons when illuminated by means of a source of light 5, which may be an incandescent lamp as illustrated or a suitable arc lamp. A monochromatic source of light, such as mercury vapor arc in a quartz or glass envelop is advantageous in giving electrons of uniform velocity. The anode preferably consists of tungsten and is deprived of gas by electron bombardment during the exhausting process, the envelop being sealed when the anode has been thoroughly freed from gas and the pressure in the envelop has been reduced to a value at which no appreciable gas ionization can occur. The grid 4 and the cathode 2 are connected respectively by conductors 6 and 7 to the secondary of a transformer 8, the primary of which is located in circuit with an antenna 9. In the antenna circuit there may be located a grounded condenser 10 but the antenna connections and structure may be the usual ones forming no part of my present invention. In the grid circuit 7, there is preferably included a source of potential 11, such as a battery which preferably is connected to maintain the grid at a definite negative potential, but in some cases the grid may be maintained at a positive potential.

In the circuit connecting the cathode and the anode, also known as the "plate circuit," is included a local source of energy, such as a battery 12, having its negative terminal connected to the cathode, and also a resistance 13. In place of this resistance a sufficiently high inductance may be used, its value depending on the frequency. The grid consists of a frame-work upon which is wound preferably very fine wire, for example, wire having a diameter of about .0004 inch, the turns being closely spaced. To the terminals of the resistance is connected a second electron-discharge device B, having

a cathode 14, adapted to be heated to incandescence by means of a battery 15, or other convenient source. The grid 16 and the cathode 14 are connected to the resistance 13 respectively by conductors 17 and 18, through a reversing switch 19. In the electrode circuit 20, 21, of the device B is included a local source of energy 22 and an electrical detecting device 23, such as any of the known forms of electromagnetic recorders or a telephone. In shunt therewith may be placed a condenser 24. In some cases a battery 25 or other source of potential may be included in the grid circuit 17. This method of connecting two amplifiers in cascade is claimed in my application, Serial No. 11,512, filed March 2, 1915, which is a division of this application.

In the system described the discharge device A, which may have relatively large distances between the grid and the electrodes, is made very sensitive to changes of grid voltages. The fact that the electrons are emitted by the cathode at uniform velocity contributes to its sensitiveness. A comparatively feeble impulse received from the antenna 8 will be accompanied by a change in the current from the local source 12 through the resistance 13. The current increases when a positive wave is superimposed on the negative grid potential. The current flowing through the resistance 13 will be greater than the current received from the antenna, and therefore, will produce greater variations in the static charge of the grid 16 of the device B than were originally received by the grid 4 of the device A. Hence, these potentials may be used to produce greatly amplified signal current. In other words, the stronger currents flowing in the electrode circuit of the device A can be used to vary the flow of electron discharge current between the cathode 14 and the anode 26 of the discharge device B which is adapted to control relatively a greater amount of energy than the device A although not necessarily so sensitive to minute voltage changes as the device A. This feature of my invention is claimed in my application Serial No. 254,334, filed Sept. 16, 1918, which is a division of this application. When the switch 19 is set so as to connect the positive terminal of the resistance 13 to the grid circuit 17, containing means for making the grid 16 negative, an increase of plate current of device A will produce an increase in the plate current of device B. The converse is the case when the connections are reversed. The variations in the electrode or plate circuit constitutes further amplification of the original signal currents and may be made great enough to operate an electromagnetic instrument 23, such as a telegraph relay, or in any convenient way to indicate the signals. In some cases an ordinary telephone may be connected to the terminals of the conductors 20, 21, to detect the amplified signals.

The system shown in Fig. 2 is in some respects similar to the system shown in Fig. 1, for example, in the character of the discharge device used, and therefore need not be again described in detail. Each device has a heated cathode *c* and an unheated anode *a*, both of which may consist of tungsten. In the system shown in Fig. 2 a number of discharge devices have been shown connected in cascade and one of the devices is provided with means for integrating the high frequency oscillations of the wave trains so as to transmit in its plate circuit variable current, which when transformed to an alternating current will correspond in frequency with the group frequency of the wave trains. Such a system permits progressive tuning in each grid circuit whereby the receiving system will select only signals having both a predetermined oscillation frequency and group frequency. This method of operation will be better understood by first considering the connections and then tracing through the method of operation.

The grid 27 of the discharge tube M is connected to the secondary of the loosely coupled air core transformer 28. The primary of the transformer is included in a grounded antenna circuit similar to that shown in Fig. 1. In the grid circuit 29 is included a source of potential 30 and across the transformer secondary is connected a condenser 31, which preferably is made adjustable. By properly proportioning the inductance of the transformer secondary and the capacity of the condenser, the oscillating circuit constituted thereby may be made resonant to a desired frequency and therefore will be largely opaque to disturbances. Hence the grid will be influenced only to a slight extent by frequencies differing from the desired predetermined frequency. As already explained the variations in the grid potential, which is preferably negative, produced by the impressed oscillations result in oscillations in the plate circuit 32 similar to those in the grid circuit. These oscillations having been produced by a local source of current 33 may be stronger than the received oscillations. They are impressed on another oscillating circuit 34, 35, by means of an air core transformer 36. The circuit 34, 35, is likewise adjusted to be opaque to undesired oscillations by properly adjusting the condenser 37. The oscillations produced in the plate circuit 38 of the device R by a local source of energy 39 are again transmitted to another local oscillating circuit 40 which is also tuned, by an air core transformer 41. It will be noted that by thus tuning successive circuits the undesired oscillations are reduced in each case in geometric proportion. This progres-

sive tuning thus produced in my present invention is described and claimed in its broad aspect in a patent of Ernst F. W. Alexanderson, No. 1,173,079.

In the present case, I secure as a novel feature tuning for both oscillation frequency and group frequency, as will be explained. The grid circuit 42 of the discharge tube S contains a condenser 43 which is shunted by a high resistance 44 and battery 45 which preferably has its negative terminal connected to the grid 46. Both the resistance and the battery are provided with an adjustable shunt 47 so that the potential of the battery and amount of resistance may be both varied or, in fact, entirely eliminated. Even when the grid 46 is not maintained at a predetermined potential it will assume some negative potential as it receives electrons from the cathode *c* and its potential is determined by the surface of the grid 46 and the rate at which the charge may leak off from the condenser plates. When the grid is positively charged it will take up electrons at a rate varying with the degree of positive charge, and when the grid is negatively charged the rate at which it absorbs electrons decreases with the degree of negative charge until a value is reached at which no more electrons are taken up. The condenser charge will come to an equilibrium when the rate of leakage is equal to the rate of charging by the electrons absorbed. This grid potential may be assumed to have a negative value represented by the line *p* in Fig. 3 which represents a diagram in which the ordinates are grid potentials and the abscissæ represent time. The actual number of oscillations in each group, of course, will be much greater than indicated in Fig. 3. When the oscillations are superimposed on the grid, assuming its potential to be *p*, Fig. 3, a positive wave 48 will cause it to take up more electrons, which are not discharged during the succeeding negative wave. Each successive wave adds its increment to the negative charge which thus accumulates on the grid and the plate of the condenser connected to it. After a certain number of oscillations have thus been received the grid has received such a negative charge that it no longer takes up more electrons than it loses. When the wave train ceases, the added negative charge leaks off as indicated by the line 50, until the grid potential again assumes its original value *p*. The capacity of the condenser 43, the potential of the battery 45, if one is used, and the resistance 44 should be so chosen that the grid 46 will have resumed its equilibrium charge before the next wave train is impressed on it.

As the current in the plate circuit 51 of the tube S is determined by the grid charge, a variable current will tend to flow therein having a frequency equal to the group frequency of the signals received from the antenna and also having a high frequency component. The high frequency component of this current may be eliminated by making the circuit responsive or resonant only to the low frequency. This may be done by providing the transformer 52 with an iron core as to introduce considerable inductance into the circuit 51 and also by shunting the primary circuit of the transformer with a condenser 53. A relatively smooth low frequency alternating current will flow in the secondary circuit 54 which may be tuned for the frequency to be selected by an adjustable condenser 55.

The selectivity of the system thus is made very great as it is opaque not only to disturbances having a different frequency than the oscillations to be received but is also opaque to aerial signals having a different group of frequency. The number of circuits connected thus in series or in cascade may be increased to any desired number.

In the system illustrated the oscillations of the circuit 54 are impressed on a grid 56, in circuit with which preferably is a source of potential 57. The currents in the plate circuit 58 produced by a local source 59 are varied as already explained by variations of grid potential. The amplified and selected signals may be recorded or detected by any suitable form of device as indicated at 60.

The grids of tubes M and R may consist of fine wire, closely spaced, the grid of the device S of coarse wire, more widely spaced, and the grid 56 of tube T of fine wire, widely spaced but these relations are not essential.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. A selective system for detecting signals consisting of groups of high frequency oscillations, comprising the combination of a plurality of circuits resonant to the frequency of the oscillations to be selected, relay means interposed between said respective circuits and operative to impress upon one circuit oscillations proportionate to oscillations in another circuit, means for integrating the high frequency oscillations in one of said circuits to produce a variable current having a frequency equal to the group frequency of the signals, a circuit connected thereto resonant to said group frequency and means for detecting current in said circuit.

2. A selective system for detecting signals consisting of a group of high frequency oscillations comprising a plurality of circuits, electron discharge devices connected to link said circuits in cascade, a local source of energy in circuit with each of said discharge devices, a series condenser included in the grid circuit of one of said discharge devices and means for detecting current in

the electrode circuit of the last discharge device of the series.

3. The combination of an electron discharge device having an electron-emitting cathode, a coöperating anode and a conducting body located near said cathode for controlling the electron discharge, a condenser connected in circuit with said body, a high resistance connected in shunt with said condenser and a local source of energy connected in circuit with the electrodes of said device.

4. The combination of a device operating with a substantially pure electron discharge, a grid for controlling the electron discharge, a condenser in circuit with said grid, a circuit shunting said condenser, a resistance and a battery in said circuit, means for varying the potential of said battery and amount of said resistance, and a local source of energy in the electrode circuit of said device.

5. A system for selecting groups of high frequency oscillations from disturbing oscillations comprising the combination of a circuit resonant to the frequency of the oscillations to be selected, a second circuit resonant to the group frequency of said oscillations, relay means interposed between said circuits operative to impress upon the second circuits amplified oscillations proportionate to oscillations in the first circuit and means for receiving and detecting a current in the second circuit.

6. The combination of an electron discharge device having an electron-emitting cathode, a coöperating anode and a grid for controlling the electron discharge, a condenser connected in circuit with said grid and a high resistance connected in shunt to said condenser.

7. The combination of an electron discharge device having an electron emitting cathode, a coöperating anode and a grid for controlling the electron discharge, a condenser connected in series relation in the grid circuit of said device and a source of potential connected in shunt to said condenser.

8. The combination of an electron discharge device having an electron-emitting cathode, a coöperating anode and a grid for controlling the electron discharge, a condenser in circuit with said grid and a circuit shunting said condenser, said circuit comprising a source of potential and a high resistance.

9. The combination of an electron discharge device having an electron emitting cathode, a plate anode, and a grid inclosed in a receptacle evacuated to such a degree that the device will operate with substantially no gas ionization, grid and plate circuits for said device, means for impressing upon the grid circuit groups of high frequency oscillations, and means for integrating the high frequency oscillations to produce in the plate circuit a variable current having a frequency equal to the group frequency of the high frequency oscillations.

10. The combination of an electron discharge device having an electron emitting cathode, an anode and a grid inclosed in a receptacle evacuated to such a degree that the device will operate with substantially no gas ionization, a condenser connected in circuit with said grid, and a high resistance connected in shunt to said condenser.

In witness whereof, I have hereunto set my hand this 27th day of October, 1913.

IRVING LANGMUIR.

Witnesses:
SAUL DUSHMAN,
HELEN ORFORD.

Exhibit D.

239

Sept. 2, 1924.

1,507,016

L. DE FOREST

RADIOSIGNALING SYSTEM

Filed Sept. 23, 1915

2 Sheets-Sheet 1

Fig 1

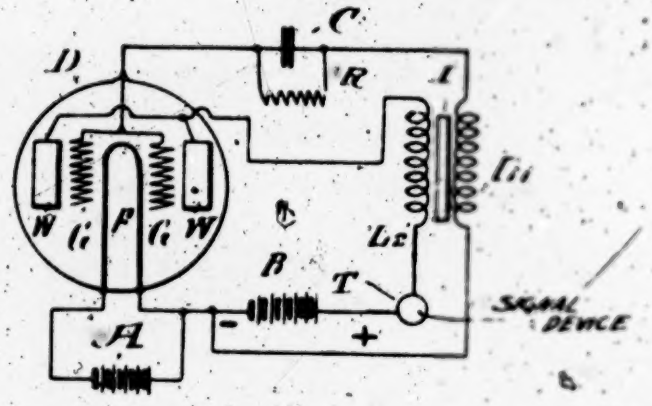
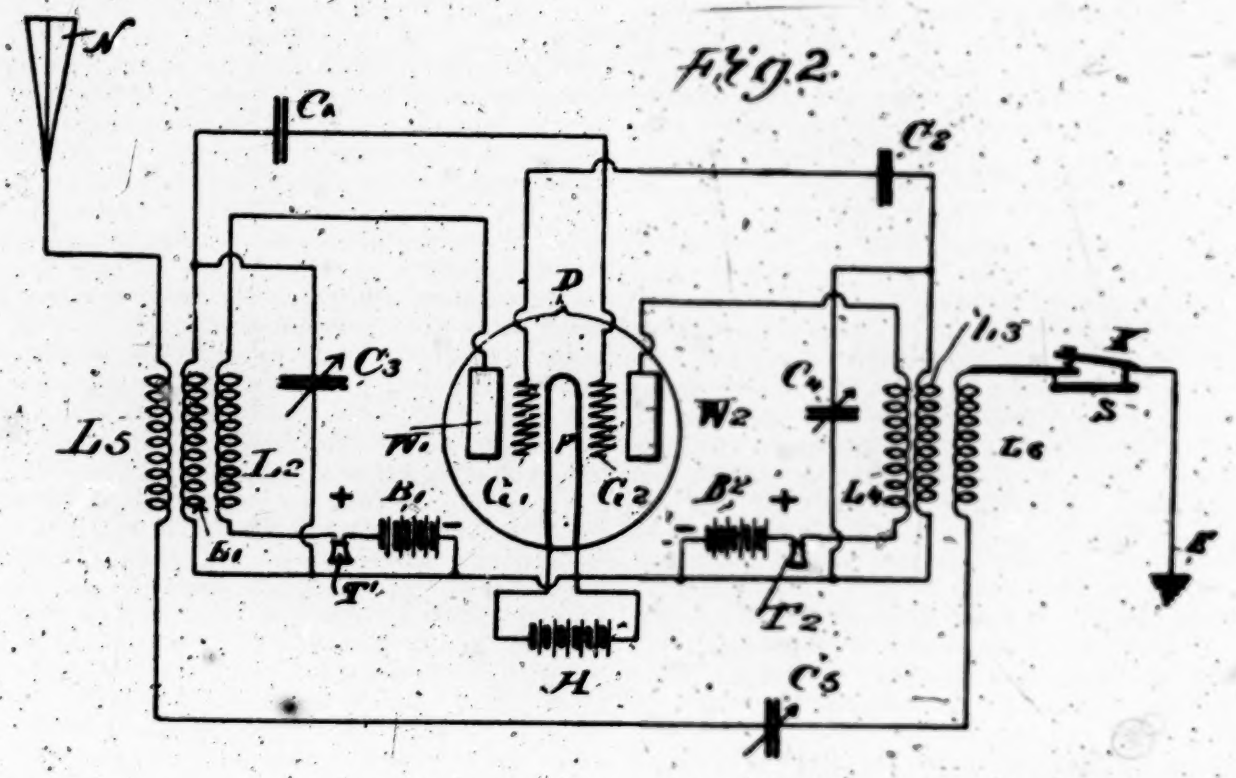


Fig 2.



Inventor
Lee de Forest

By his Attorney
Samuel E Darby

TOP VIEW of CHASSIS

BOTTOM VIEW of CHASSIS

FRONT VIEW

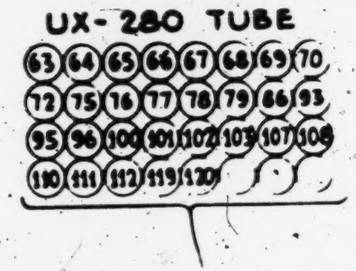
ENLARGED REAR INTERIOR VIEW

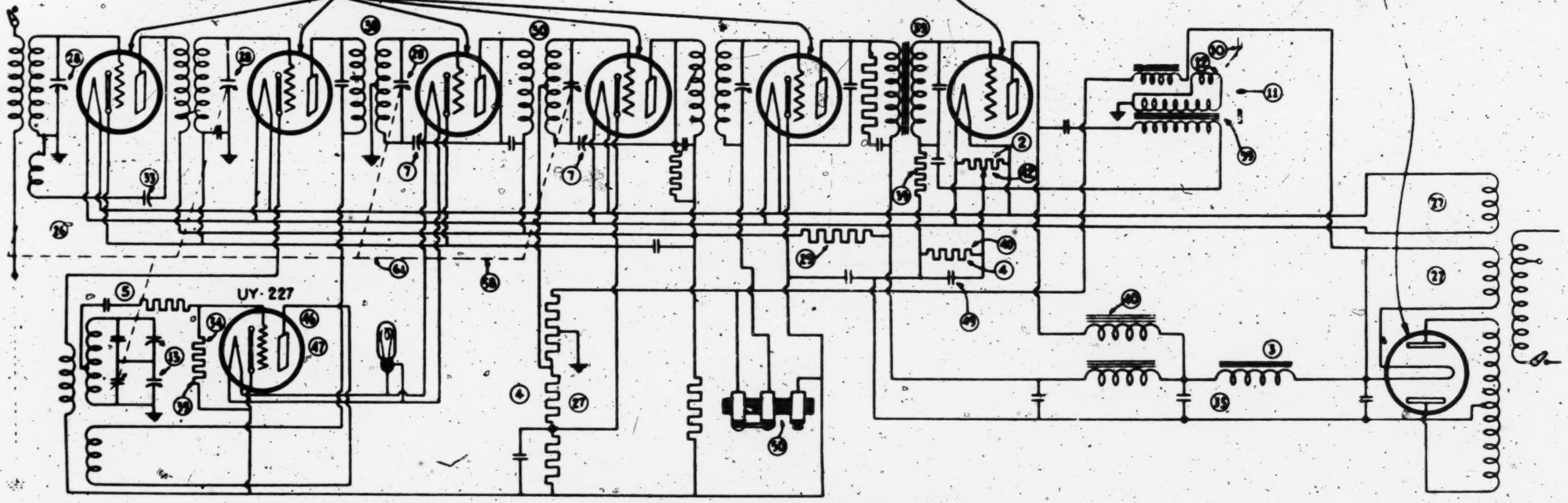
REAR INTERIOR VIEW

UY-227 TUBE

UX-245 TUBE

UX-280 TUBE





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Sept. 2, 1924.

1,507,016

L. DE FOREST

RADIOSIGNALING SYSTEM

Filed Sept. 23, 1915

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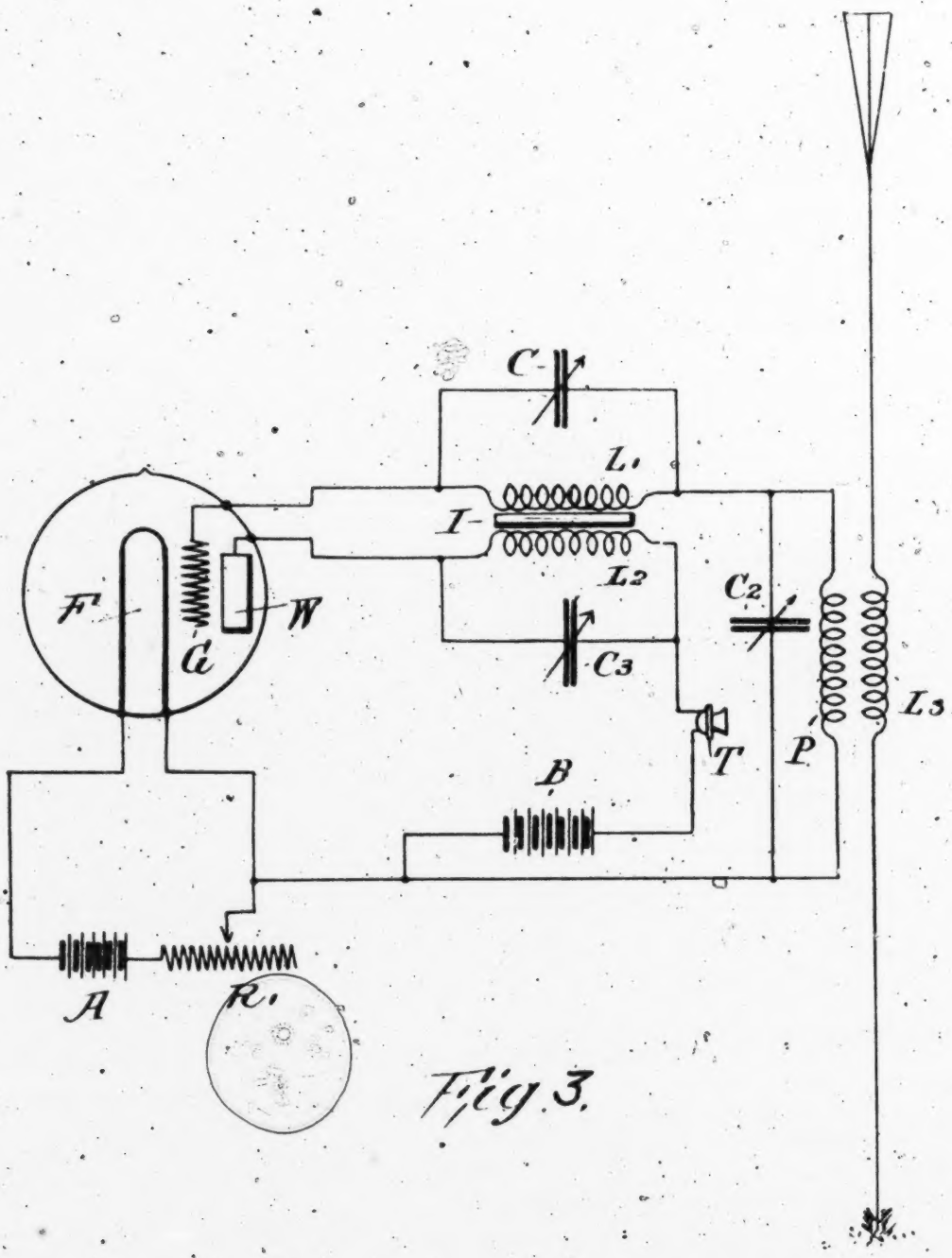

Fig. 3.

Inventor

Lee de Forest

By his Attorney

Samuel E. Darby

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Patented Sept. 2, 1924. 1,507,016.

UNITED STATES PATENT OFFICE.

LEE DE FOREST, OF NEW YORK, N. Y., ASSIGNOR TO DE FOREST RADIO TELEPHONE AND TELEGRAPH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

RADIOSIGNALING SYSTEM.

Application filed September 23, 1915. Serial No. 51,176.

To all whom it may concern:

Be it known that I, LEE DE FOREST, a citizen of the United States, residing in the city of New York, county of Bronx and State of New York, have made a certain new and useful Invention in Radiosignaling Systems, of which the following is a specification.

This invention relates to radio signaling systems.

The object of the invention is to provide a radio signaling system which is simple and efficient in operation.

Further objects of the invention will appear more fully hereinafter.

The invention consists substantially in the construction, combination, location and relative circuit arrangements all as will be more fully hereinafter set forth, as shown in the accompanying drawing and finally pointed out in the appended claims.

Referring to the drawing, Figs. 1, 2, 3, all show various circuit arrangements embodying my invention.

In accordance with my present invention, I propose to employ an evacuated vessel with hot and cold electrodes therein, known as the audion, together with suitable circuit connections to cause the audion to operate as a generator of undamped oscillations, and to so arrange the circuit connections to cause the audion to operate as a generator of undamped oscillations, and to so arrange the circuit connections referred to so as to allow such a generator to also be employed as a detector. The underlying principle of my present invention as will be more fully described, is the association, preferably by inductive coupling means, of the circuits of the cold electrodes of the audion.

In Fig. 1 I have shown a simple circuit arrangement for accomplishing the objects of my invention wherein D is the exhausted vessel, F the hot or filament electrode, and A is the battery for heating the same in the usual and well known manner and controlled by the resistance R, as shown in Fig. 4, if desired. G designates the grid or "input" electrodes and W the wing or "output" electrodes. Preferably, and as shown, though I do not desire to be limited in this respect, the wing and grid electrodes are arranged in pairs, both grids and both wings being connected in parallel. The input electrodes G are connected to one side of the filament F by a circuit including therein one coil of a transformer L_1. The output electrodes W are likewise connected to the filament F by a circuit including the coil L_2 of the transformer, and the usual source of voltage such as battery B or other direct current source with its positive terminal connected to the cold electrodes W through the telephone or signal indicating device T, as shown.

In series with the grid or input electrodes G and in the circuit thereof I propose to place a stopping condenser C, and to shunt around this condenser a high and preferably non-inductive resistance R, of from 25,000 to 100,000 ohms.

The transformer whose coils are L_1 L_2 may be a "telephone transformer" as shown, with the coils having several thousands turns each surrounding an iron core I, in which case the system will oscillate at "audio" or low frequencies, or the windings may contain only a few hundreds of turns each, of several milli-henries inductance, and the coils more or less spatially separated or "loosely coupled" in which case the system will oscillate at high or "radio" frequencies.

In the first case, that is, when the system is oscillating in "audio" frequencies the system becomes a "siren" and will generate powerful telephonic currents having a clear musical note heard in the telephone receiver T. The pitch of this note can be varied by altering the inductance of either of the coils L_1 L_2 in any well known manner, or by altering their coupling as by withdrawing from the transformer the iron core I_1 or by varying the distributed capacity of the winding or the spatial relation of the windings, or the capacity of the condenser C, the value of the resistance R, or the potential of the battery B, or the brightness of the filament F in any manner well known in the art.

When such an oscillating system as shown in Fig. 1, is employed for generating radio frequencies, the capacity of the ordinary telephone wires leading to the telephone receiver or signaling device T is usually sufficient to form a by-path around the high-impedance and high resistance of this device. The impedance of source B to the

radio frequency oscillations, I have found to be insufficient to materially dampen the same. My invention as defined in the claims is not to be limited in this respect however, for other expedients will readily suggest themselves to those skilled in the art.

If the system described is to be employed as a generator of high frequency oscillations for transmission purposes the signal device T may be a transmitter if desired. An alternative arrangement is shown in Fig. 2 wherein a key indicated at K is inserted in the antenna-earth system. As it is obvious that my invention applies to either transmitting or receiving systems, I wish it to be understood that by the term "signal device," as used throughout the specification, I mean broadly either a transmitter or a receiver of signals.

When an audion with its cold electrodes associated or inter-linked as shown, is used as a receiving system its ordinary sensitiveness as a detector is many times increased by virtue of the "kick-back" or progressively amplifying effect of the received signal impulses.

In Fig. 2 I have illustrated a "compound audion" containing two insulated grid members G_1 and G_2, and two insulated wing members W_1 and W_2, each of the four electrodes being connected to the filament F by a circuit containing inductances L_3, L_1, L_2, and L_4, respectively. The coils L_1, L_2, may be inductively associated as shown, and likewise inductances L_3, L_4, may be inductively associated, so as to allow reaction of the one upon the other in each pair.

As shown, I prefer to associate the grid nearest one wing with the current of the wing lying furthest away, usually on the opposite side of the filament, as thereby I find that the reaction of the circuits upon each other is the most violent. Each wing W_1 W_2, has, preferably, its own source of electro-motive force as indicated at B_1, B_2, respectively, although I am not to be limited in this respect as it is obvious that a common source may be employed. In the circuit of the sources B_1 and B_2, I employ telephone receivers T_1, T_2, preferably, one receiver for each ear of the operator. I employ the usual stopping condensers C_1 and C_2 in the circuits of the grids G_2 and G_1, respectively, and the variable capacities C_3 and C_4, shunted around the coils L_4, L_3, to render the grid circuits oscillatory. The coils L_1, L_2, and L_3, L_4 of the two oscillating circuits are associated inductively or otherwise to the same antenna-earth system comprising the usual elements N, L_5, C_5, L_6, and E, as shown, whether the arrangement be used for receiving or transmitting signals.

When using the arrangement shown in Fig. 2, as a generator of alternating currents the sources of the wing currents, B_1 and B_2, respectively, should be of high voltage, as for example, direct current generators of from 600 to 1200 volts.

In the antenna-earth system, I show a transmitting key K connected directly therein. I also employ a hand operated switch S shunted around the same to cut the key K out when the system is used as a receiving system. The periodicities of the oscillating circuits L_1, C_3 and L_2, C_4, should be made the same, or nearly the same by properly adjusting their respective capacities or inductances. If the natural rates of oscillation of these two circuits are not quite the same, beats or interferences are set up in the antenna, resulting in a harmonic variation of amplitudes of the radiated wave train which may be of practical value when signaling to receiving stations where the receiver can give audible responses only to interrupted or intermittent trains of waves.

It will be noted that in accordance with my invention, the connection of the terminals of the wing and grid coils is important. I have found that the oscillations set up are much more intense when one end of one of these coils is connected to the grid or plate as the case may be, than when the opposite end of that coil is thus connected. In other words, by reversing coil L_2 relative to coil L_1, the oscillations set up may be found to be much more intense than before such reversal of connections. The principle here involved is that the phase of the two pulsating currents in the coils L_1 and L_2, shall be so displaced relative to each other that a positive charge or surge upon the wing electrodes shall be next followed by a negative charge or surge upon the grid, the effect of this being that thereby an increase of current through the coil L_2 to the wing results in a succeeding increase in the resistance of the gas path between the wing and the filament electrodes, and conversely, a diminution in the current from the wing to the filament electrodes results in a succeeding decrease in the resistance of the path. It is by these means that one circuit is enabled to react upon the other so that successively increasing pulsations are set up in the two associated circuits until the losses by resistance, leakage and load, are equal to the increment of energy supplied from the battery or source B B_1, B_2 whereupon a stable condition of oscillation or pulsation is attained.

In Fig. 3 I have shown a modified arrangement wherein the wing and grid circuits are inductively associated as in Fig. 1, through coils L_1 and L_2 around which are shunted capacities C and C_2, respectively. In this arrangement I prefer to associate the grid circuit with the antenna earth circuit through inductance L_3 of the antenna

system. In this instance I shunt a capacity C_3 around the inductance P as shown. The core I is also used in coupling between the oscillating circuits of the cold electrodes, and the reaction effect is secured between these circuits as hereinbefore described.

It will be understood that many other circuit arrangements will readily occur to those skilled in the art without departing from the broad scope of my invention as defined in the claims. Therefore, having set forth the objects and nature of my invention, and having shown and described various embodiments thereof, what I claim as new and useful and of my own invention and desire to secure by Letters Patent, is,—

1. In a radio signaling system, an evacuated vessel including hot and cold electrodes therein, said cold electrodes being located at relatively different distances from said hot electrode, separate circuits connecting each of the cold electrodes to the hot electrode, said circuits being inductively associated.

2. In a radio signaling system, an evacuated vessel containing hot and cold electrodes therein, said cold electrodes being located at relatively different distances from said hot electrode, separate oscillating circuits connecting each of said cold electrodes to said hot electrode, said circuits being inductively associated.

3. In a radio signaling system, an evacuated vessel including hot and cold electrodes therein, said cold electrodes being located at relatively different distances from said hot electrode, separate circuits connecting each of the cold electrodes to the hot electrode, said circuits being inductively associated, and an antenna system associated with said circuits.

4. In a radio signaling system, an audion including hot and cold electrodes therein, said cold electrodes being located at relatively different distances from said hot electrode, separate circuits connecting each of said cold electrodes to said hot electrode, and means to set up successively increasing pulsations in said circuits, and an antenna system inductively associated with said circuits.

5. In a radio signaling system, an audion including hot and cold electrodes therein, said cold electrodes being located at relatively different distances from said hot electrode, separate oscillating circuits connecting each of the cold electrodes to said hot electrode, said circuits being inductively coupled and an antenna system inductively associated with said coupling.

6. In a radio signaling system, an evacuated vessel containing hot and cold electrodes therein, said cold electrodes being located at relatively different distances from said hot electrode, separate circuits connecting each of said cold electrodes with said hot electrode, said circuits being inductively associated, a source of electromotive force and a signaling device being included in one of said circuits.

7. In a radio signaling system, an evacuated vessel containing hot and cold electrodes therein, said cold electrodes being located at relatively different distances from said hot electrode, circuits connecting each of said cold electrodes with said hot electrode, said circuits being inductively coupled, a source of electromotive force and a signaling device being included in one of said circuits and an antenna system inductively associated with said coupling.

8. In a radio signaling system, an evacuated vessel containing hot and cold electrodes therein, said cold electrodes being located at relatively different distances from said hot electrode, circuits connecting each of said cold electrodes with said hot electrode, said circuits being associated, a source of electromotive force and a signal indicating device being included in one only of said circuits and an antenna system associated with said circuits, and means for operating said radio signaling system as a transmitting station.

9. In a radio signaling system, an evacuated vessel containing hot and cold electrodes therein, circuits connecting each of said cold electrodes with said hot electrode, said circuits being inductively associated, a source of electromotive force and a signal indicating device being included in one of said circuits and an antenna system associated with said circuits, and means for operating said signaling system as a receiving station.

10. In a radio signaling system, an audion including hot and cold electrodes therein, said cold electrodes being located at relatively different distances from said hot electrode, separate circuits connecting each of said cold electrodes to said hot electrode, said circuits being inductively associated with each other.

11. In a radio signaling system, an evacuated vessel containing a hot electrode and a plurality of grid electrodes and a plurality of wing electrodes, circuits connecting each of said grid electrodes and said wing electrodes with said hot electrode, the circuits of the grid electrodes being inductively associated with the circuits of the wing electrodes.

12. In a radio signaling system, an evacuated vessel containing a hot electrode and a plurality of grid electrodes and a plurality of wing electrodes, circuits connecting each of said grid electrodes and said wing electrodes with said hot electrode, the circuits of the grid electrodes being associated with the circuits of the wing electrodes respec-

tively, and a signal indicating device included in each of the circuits of said wing electrodes.

13. In a radio signaling system, an evacuated vessel containing a plurality of wing electrodes and a plurality of grid electrodes, a filament electrode interposed between said grid electrodes and between said wing electrodes, circuits connecting each of said wing and grid electrodes with said filament electrode, the circuits of said grid electrodes being inductively associated with the circuits of said wing electrodes respectively.

14. In a radio signaling system, an evacuated vessel, containing a plurality of wing electrodes and a plurality of grid electrodes, a filament electrode interposed between said grid electrodes and between said wing electrodes, circuits connecting each of said wing and grid electrodes with said filament electrode, the circuit of each of said grid electrodes being inductively associated with the circuit of said wing electrode on the opposite side of said filament electrode.

15. In a radio signaling system, an evacuated vessel containing a plurality of wing electrodes, and a plurality of grid electrodes, a filament electrode interposed between said grid electrodes and between said wing electrodes, circuits connecting each of said wing and grid electrodes with said filament electrode, the circuits of said grid electrodes being inductively coupled with the circuits of said wing electrodes respectively.

16. In a radio signaling system, an evacuated vessel containing a plurality of wing electrodes and a plurality of grid electrodes, a filament electrode interposed between said grid electrodes and between said wing electrodes, circuits connecting each of said wing and grid electrodes with said filament electrode, the circuits of said grid electrodes being inductively coupled with the circuits of said wing electrodes respectively, and an antenna system inductively associated with said coupling.

17. In a radio signaling system, an evacuated vessel containing a plurality of wing electrodes, and a plurality of grid electrodes, a filament electrode interposed between said grid electrodes and between said wing electrodes, circuits connecting each of said wing and grid electrodes with said filament electrode, the circuits of said grid electrodes being inductively coupled with the circuits of said wing electrodes respectively, the circuit of each of said grid electrodes being inductively coupled with the circuit of said wing electrode on the opposite side of said filament.

18. In a radio signaling system, an evacuated vessel containing a plurality of wing electrodes, and a plurality of grid electrodes, a filament electrode interposed between said grid electrodes and between said wing electrodes, circuits connecting each of said wing and grid electrodes with said filament electrode, the circuits of said grid electrodes being inductively coupled with the circuits of said wing electrodes respectively, the circuit of each of said grid electrodes being inductively coupled with the circuit of said wing electrode on the opposite side of said filament, and an antenna system inductively associated with each said coupling.

19. In a system for generating oscillations, a work circuit, and means for generating and transmitting the generated oscillations comprising an oscillatory circuit having two electrodes in an exhausted receptacle, and a second circuit inductively coupled thereto having a conducting body interposed between said electrodes.

20. In a system for generating oscillations, a work circuit, and means for generating and transmitting the generated oscillations comprising an oscillatory circuit having two electrodes, a second circuit inductively coupled thereto and having a conducting body interposed between said electrodes.

21. In a system for generating oscillations, a work circuit, and means for generating and transmitting the generated oscillations comprising an oscillatory circuit having two electrodes, a second circuit inductively coupled thereto and having a conducting body interposed between said electrodes and means for varying the frequency of the produced oscillations.

22. In a system for generating oscillations, a work circuit, and means for generating and transmitting the generated oscillations comprising an oscillatory circuit having two electrodes means for producing a flow of current between said electrodes and a second circuit inductively coupled with the first circuit and having a conducting body interposed between said electrodes.

23. In a system for generating oscillations, a work circuit, and means for generating and transmitting the generated oscillations comprising an oscillatory circuit having two electrodes means for producing a flow of current between said electrodes and a second oscillatory circuit inductively coupled with the first oscillatory circuit and having a conducting body interposed between said electrodes.

24. The method of generating alternating currents which consists in causing current to flow in one of two inductively coupled circuits, and varying the flow of current in the first circuit by impressing the potential induced in the second circuit upon a conducting body interposed between two electrodes in the first circuit.

25. Means for producing sustained electrical oscillations comprising an oscillatory circuit having two electrodes in an exhaust-

ed receptacle and a second circuit coupled thereto having a conducting body interposed between said electrodes.

26. Means for producing sustained electrical oscillations comprising an oscillatory circuit having two electrodes, a second circuit coupled thereto having a conducting body interposed between said electrodes, and means for varying the frequency of the produced oscillations.

27. Means for producing sustained electrical oscillations comprising an oscillatory circuit having two electrodes, means for producing a flow of current between said electrodes, and a second circuit coupled with the first having a conducting body interposed between said electrodes.

28. The method of producing electrical alternating currents which consists in causing current to flow in one of two coupled circuits and varying the flow of current in the first circuit by impressing the potential induced in the second circuit upon a conducting body interposed between two electrodes in the first circuit.

29. In a system for generating electrical oscillations, a work circuit, and means for generating and transmitting the generated oscillations to said work circuit comprising an evacuated vessel having a hot electrode, a cold plate electrode and a cold grid electrode, said cold electrodes being electrically associated with each other, and a source of current for the hot electrode.

30. The method of producing high frequency alternating currents, which consists in causing current to flow in one of two associated circuits and varying the flow of current in the first circuit by impressing a charge induced in the second circuit upon an element in the space between the electrodes respectively included in said second circuit.

31. Means for generating high frequency oscillations, including an evacuated vessel having separated wing, grid and filament electrodes therein, circuits for said electrodes, and a source of current supply having its terminals respectively connected to two of said electrodes and operating to generate oscillations in one of said electrode circuits.

32. The combination with a work circuit and means for generating and transmitting the generated alternating currents to said work circuit, comprising an evacuated vessel having a hot and a plurality of cold electrodes therein, said cold electrodes being located at relatively different distances from said hot electrode, means to supply current to said electrodes, and circuit connections between said electrodes.

33. The combination with a work circuit and means for generating and transmitting the generated alternating current to said work circuit, comprising an evacuated vessel having a hot and a plurality of cold electrodes therein, said cold electrodes being located at relatively different distances from said hot electrode, a circuit connection between the cold electrodes, and means for impressing an electromotive force in the space between the cold and hot electrodes, and means to supply current to the hot electrode.

34. The combination with a work circuit and means for generating and transmitting the generated alternating currents to said work circuit, comprising an evacuated vessel having a hot and a plurality of cold electrodes therein, said cold electrodes being located at relatively different distances from said hot electrode, a circuit connection between the cold electrodes, a circuit connection between one of the cold electrodes and one side of the hot electrode, a source of current included in said last-mentioned circuit connection, and means for supplying current to the hot electrode.

35. A work circuit and means for generating and transmitting the generated oscillations to said work circuit, comprising an audion and its associated circuits.

36. The combination with a work circuit and means for generating and transmitting the generated oscillations to said work circuit, comprising an evacuated vessel having filament, grid and plate electrodes therein, means to supply current to said electrodes, and circuit connections between said electrodes.

37. In a system for generating electrical oscillations, an evacuated vessel having a hot electrode, a cold plate electrode and a controlling electrode, circuits connected to said cold plate electrode and said controlling electrode, respectively, and coupled with each other, and a source of current for the hot electrode.

38. The combination with a translating device, of means for generating and transmitting to said device the generated oscillations, comprising an evacuated vessel having filament, grid and plate electrodes, means to supply current to said electrodes, and circuit connections between said electrodes.

39. Means for producing sustained electrical oscillations, comprising an oscillatory circuit having two electrodes, one of said electrodes comprising an incandescent filament, a second circuit coupled to said oscillatory circuit and having a controlling grid electrode for regulating the discharge between said two electrodes.

40. Means for producing electrical oscillations comprising an oscillatory circuit having two electrodes, one of said electrodes comprising an incandescent filament, a second circuit coupled thereto having a con-

trolling grid electrode associated with said electrodes, and means for varying the frequency of the produced oscillations.

41. The method of producing electrical oscillations with an incandescent filament thermionic discharge device having two coupled circuits each connected to the incandescent filament thereof, which consists in causing current to flow in one of the said two coupled circuits and varying the flow of current in said first circuit by impressing the potential induced in the second circuit upon a controlling grid electrode regulating the current flow in the first circuit.

In testimony whereof I have hereunto set my hand in the presence of a subscribing witness, on this 18th day of September, A. D., 1915.

LEE DE FOREST.

Witness:
S. E. DARBY.

AFFIDAVIT OF JOHN R. BINNS IN OPPOSITION TO DEFENDANT'S COUNTER-MOTION FOR SUMMARY JUDGMENT.

[Filed February 11, 1948.]

State of New York)
) ss.:
County of New York)

John R. Binns, being duly sworn, deposes and says:

1. That he is the John R. Binns who made affidavit in support of plaintiff's motion for summary judgment filed on November 10, 1947, in the above-entitled action.

2. That he has read defendant's motion for summary judgment and the affidavit of George K. Woodworth in support thereof and that that affidavit, admittedly made almost solely on information and belief, comprises, except to the references to official records, largely general and sweeping conclusions obviously based on hearsay and rumor since such conclusions are to such a great extent inaccurate, incomplete, contrary to fact, or subject to a combination of these attributes; that by way of illustration he is taking up the most glaring examples in the order in which they appear in Mr. Woodworth's affidavit, reference being made to paragraphs as numbered in Mr. Woodworth's affidavit:

Par. 2(e), page 3

The statement "no patent owned by Hazeltine has ever held to be valid and infringed since the original Hazeltine neutrodyne patents" is in error. In *Latour Corporation* v. *E. B. Latham* (S.D.N.Y.–1934) 23 F.S. 869, Latour patent Re. 16,461 owned by Hazeltine was held valid and infringed. In addition, Wheeler patent Re. 19,744 owned by Hazeltine was held valid and infringed by the District Court for the Eastern District of Michigan, Southern Division (Judge Lederle—unreported) which holding was affirmed on appeal in a vigorous opinion by the Circuit Court of Appeals for the Sixth Circuit reported at 117 F. (2d) 238.

PATENTS COVERING CIRCUITS AND APPARATUS

GENERAL ELECTRIC CO.

1	ALEXANDERSON	1 375 019	FEB	1933
	TUNED RADIO FREQUENCY AMPLIFIER			
2	WHITE	1 195 635	AUG	1916
	A C FILAMENT HEATING - CENTER TAP			
3	HULL	1 551 777	DEC	1934
	RECTIFIED A C AND FILTER			
4	LANGMUIR	1 273 027	JULY	1918
	PLATE CURRENT FOR GRID BIAS			
5	LANGMUIR	1 383 450	OCT	1935
	GRID LEAK AND CONDENSER			
6	LANGMUIR	1 315 094	AUG	1936
	ENERGY AMPLIFICATION - POWER TUBE			
7	RICE	1 356 118	MAR	1937
	OSCILLATION PREVENTION			
8	ALEXANDERSON	1 465 961	AUG	1960
	SUPERHETERODYNE			
9	ALEXANDERSON	1 506 151	SEP	1961
	SUPERHETERODYNE			
10	RICE	1 651 646	NOV	1964
	BAFFLE FOR LOUD SPEAKER			
11	HAGENLOCKER	1 800 913	OCT	1965
	CONCENTRICALLY CONDUCTED CORE			
12	KELLOGG	1 707 017	APR	1966
	DYNAMIC TYPE LOUD SPEAKER			
13	CARLSON	1 748 231	DEC	1966
	OSCILLATOR TUNING EQUALIZATION			
14				
15				
16				
17				
18				
19				

RADIO CORPORATION

20	HEILAND	1 339 052	SEPT	1914
	BEAT NOTE RECEPTION			
21	HEILAND	1 366 108	JULY	1918
	GRID LEAK FOR OSCILLATOR			
22	HARRISON	1 404 605	FEB	1941
	CONSTANT BEAT FREQUENCY			
23	HARRISON	1 491 771	APR	1941
	DOUBLE DETECTION			
24	HARRISON	1 491 774	APR	1941
	SUPERHETERODYNE RECEPTION			
25	HEILAND	1 566 081	JUNE	1942
	HETERODYNE DETECTOR			
26	[illegible]	1 618 017	FEB	1944
	[illegible] CONTROL			
27	ARNOLD	1 656 138	MAR	1945
	[illegible]			
28	[illegible]	1 656 581	[illegible]	1945
	VARIABLE CONDENSER CONSTRUCTION			
29	LEVENBERG	1 670 091	MAY	1949
	NOISE ELIMINATION CIRCUIT			
30	LOFTIN ET AL	1 673 126	JUNE	1946
	CAPACITATIVE PLATE CIRCUIT			
31				

A.T.&T. CO AND WESTERN ELECTRIC CO

32	ARNOLD	1 356 845	MAR	1921
	HEATING TUBES IN AMPLIFIER WITH POWER TUBE			
33	HARTLEY	1 383 813	JULY	1921
	REVERSE FEED BACK			
34	DE FOREST	1 416 320	SEP	1922
	GRID LEAK FOR OSCILLATOR			
35	DE FOREST	1 501 878	OCT	1999
	FILTER IN PLATE - SUPPLY LEADS			
36	LOWENSTEIN	1 551 764	AUG	1924
	NEGATIVE GRID BIAS			
37	NICHOLS	1 537 878	DEC	1926
	REVERSE FEED BACK			
38	ARNOLD	1 546 252	AUG	1927
	STRAIGHT LINE AMPLIFICATION			
39	DE FOREST	1 577 605	MAY	1928
	GRID LEAK			
40	WILSON	1 603 835	JAN	1926
	LOAD BALANCED BY UNIFORM PLATE CURRENT			
41	MAYNES	1 636 766	AUG	1929
	[illegible]			
42	HEISING	1 656 058	OCT	1935
	A.C FILAMENT SUPPLY			
43	HEISING	1 695 596	AUG	1966
	CHOKE IN GRID LEAK CIRCUIT			
44	NICHOLSON	1 733 613	JUNE	1960
	[illegible]			
45	ARNOLD	1 766 592	AUG	1960
	[illegible]			
46	DE FOREST	1 807 616	MAY	1931
	OSCILLATION GENERATOR			
47	DE FOREST	1 809 817	SEP	1906
	OSCILLATION GENERATOR			
48	ARNOLD	1 811 854	JAN	1941
	AMPLIFICATION WITHOUT DISTORTION			
49	COCCARINI	1 846 881	MAR	1942
	FILTER IN SHUNT TO BIASING RESISTANCE			
50	CRAFT	1 879 675	SEP	1932
	[illegible]			
51	OHL	1 906 970	OCT	1965
	HEATER BIASED PLUS WITH RESPECT TO CATHODE			
52	LEVY	1 934 038	NOV	1966
	SUPERHETERODYNE RECEIVER			
53	KENDALL	1 964 122	NOV	1966
	SUPERHETERODYNE RECEIVER			
54				
55				

WESTINGHOUSE ELECTRIC & MFG CO

56	PEDERSEN	1 950 841	JAN.	1970
	HETERODYNE RECEPTION			
57	PEDERSEN	1 956 126	JAN.	1970
	HETERODYNE DETECTION			
58	PEDERSEN	1 956 133	OCT	1933
	UNICONTROL			
59	CHUBB	1 971 864	SEPT	1955
	NICKEL-STEEL TRANSFORMER CORE			
60	ARMSTRONG	1 342 885	JUNE	1957
	SUPERHETERODYNE RECEIVER			
61	HOGAN	1 863 319	DEC	1957
	UNICONTROL			
62				

PATENTS COVERING TUBES UY 227 - UX 245 AND UX 280

GENERAL ELECTRIC CO.

					UY 227	UX 245	UX 280
63	DUSHMAN	1 022 183	APR	1939			
	[illegible]						
64	COOLIDGE	1 082 933	DEC	1880			
	DUCTILE TUNGSTEN FILAMENT						
65	ELDRED	1 140 134	MAY	1931			
	LEAD-IN WIRE DUMETALLIC						
66	ELDRED	1 140 136	MAY	1931			
	LEAD-IN WIRE DUMETALLIC						
67	COOLIDGE	1 203 488	OCT	1933			
	METHOD OF EXHAUST						
68	LANGMUIR	1 244 217	OCT	1956			
	[illegible]						
69	VAN HEUSEN	1 266 247	APR	1955			
	BORATED LEAD-IN WIRES						
70	DUSHMAN	1 281 165	DEC	1938			
	ANODE SYMMETRICAL ABOUT CATHODE						
71	PACZ	1 295 017	APR	1936			
	METHOD OF MAKING TUNGSTEN FILAMENT						
72	PRATT	1 314 070	APR	1938			
	[illegible]						
73	LANGMUIR	RE 18 270	JAN	1930			
	GAS WOUND ON FRAME WORK						
74	PACZ	1 338 060	MAR	1938			
	NON-SAG TUNGSTEN FILAMENT						
75	MITCHELL	1 415 838	MAY	1938			
	[illegible]						
76	[illegible]	[illegible]	JUNE	1941			
	LEAD-IN WIRE, DUMETALLIC						
77	LANGMUIR	1 415 844	MAR	1941			
	[illegible]						
78	LANGMUIR	1 [illegible]	DEC	1938			
	[illegible]						
79	MITCHELL	1 [illegible]	JUNE	1940			
	GETTER SUPPORT IN TUBE						
80	PICARD	1 [illegible]	NOV	1944			
	EQUIPOTENTIAL CATHODE						
81							
82							

RADIO CORPORATION

83	SKINNER *2	1 [illegible] (1)	JUNE	1945			
	ELECTRODE SPACING DISC						
84							
85							

A.T.&T. CO AND WESTERN ELECTRIC CO.

86	NICOLSON	1 [illegible]	DEC	1933			
	ALKALINE EARTH OXIDE COATED FILAMENT						
87	NICOLSON	RE 18 [illegible]	DEC	1930			
	HELICAL ELECTRODE SUPPORTED ABOVE PRESS						
88	NICOLSON	1 [illegible]	MAR	1934			
	GETTER SUPPORT FOR ELECTRODES						
89	NICOLSON	1 [illegible]	JUNE	1936			
	INSULATING SUPPORT FOR ELECTRODES						
90	ARNOLD	1 [illegible]	MAR	1921			
	[illegible]						
91	ARNOLD	1 [illegible]	MAY	1921			
	[illegible]						
92	ARNOLD	[illegible]	DEC	1937			
	PARALLEL ELECTRODE SUPPORTS						

					UY 227	UX 245	UX 280
93	ARNOLD	1 [illegible]	DEC	1937			
	ELECTRODE SUPPORTED OUTSIDE OF ELECTRON STREAM						
94	ARNOLD	1 [illegible]	NOV	1938			
	VOLTAGE AMPLIFIER TUBE						
95	WILSON	1 [illegible]	JUNE	1939			
	[illegible]						
96	RANDOL	1 [illegible]	MAY	1940			
	ELECTRODES PARALLEL TO PRESS						
97	ARNOLD	1 [illegible]	MAY	1940			
	RIGID RELATION OF ELECTRODES						
98	NICOLSON	1 [illegible]	JUNE	1940			
	EQUIPOTENTIAL CATHODES						
99	VAN der BIJL	1 [illegible]	DEC	1940			
	REINFORCED ANODE PLATE						
100	VAN der BIJL	1 [illegible]	JUNE	1941			
	PLATE FLANGED FOR STANDARDS						
101	NICOLSON	1 [illegible]	JUNE	1941			
	SUPPORTING MEANS FOR ELECTRODES						
102	HOOVER	1 [illegible]	JULY	1941			
	METHOD OF COATING FILAMENT WITH OXIDES						
103	KELLY	1 [illegible]	DEC	1941			
	[illegible]						
104	VAN der BIJL	1 [illegible]	DEC	1940			
	METALLIC SUPPORTING MEANS FOR ELECTRODES						
105							
106							

WESTINGHOUSE ELECTRIC & MFG CO

107	CHUBB	1 [illegible]	JULY	1930			
	PROTECTIVE WELDING PROCESS						
108	LOEVERS	1 [illegible]	APR	1932			
	[illegible]						
109	LEDERER	1 [illegible]	APR	1933			
	THORIATED TUNGSTEN FILAMENT						
110	CHUBB	1 [illegible]	APR	1935			
	[illegible]						
111	WHITHUP	1 [illegible]	DEC	1938			
	[illegible]						
112	HOYT	1 [illegible]	FEB	1936			
	[illegible]						
113	[illegible]	[illegible]	MAR	1935			
	[illegible]						
114	HALL	1 [illegible]	JULY	1936			
	[illegible]						
115	HALL	1 [illegible]	JULY	1936			
	[illegible]						
116	[illegible]	[illegible]	OCT	1941			
	[illegible]						
117	[illegible]	[illegible]	OCT	1943			
	[illegible]						
118	[illegible]	[illegible]	JAN	1944			
	[illegible]						
119	[illegible]	[illegible]	NOV	1943			
	[illegible]						
120	[illegible]	[illegible]	DEC	1943			
	[illegible]						

NOTE: WESTINGHOUSE HAS EXCLUSIVE LICENSE FOR VACUUM TUBE MANUFACTURE WITH RIGHT TO GRANT SUBLICENSES

On writ of certiorari the Supreme Court reversed, holding the patent invalid (313 U.S. 259). Nevertheless, the favorable concurring holdings by the District Court and the Circuit Court of Appeals negatives the inference of Mr. Woodworth's statements that Hazeltine has put into litigation only frivolous and unimportant patents.

Par. 2(g), page 4

The statement that Hazeltine hires engineers to make inventions to order is obviously hearsay; it is also irrelevant and untrue. Hazeltine hires engineers fundamentally to advance the progress of the radio art as enjoined by the United States Constitution, Article I, Section 8, and to provide engineering services to its licensees. Resulting inventions are incidental and by-products of Hazeltine's fundamental research and development program.

Par. 2(h), page 4

The distorted reasoning by which Mr. Woodworth deduces that only a small fraction of Hazeltine's royalty income during 1941 was directed to research and development is obviously based on hearsay. Nevertheless, the statement is still irrelevant since Hazeltine has for many years followed the policy of distributing the portion of its royalty income between ordinary broadcast receivers, frequency-modulation receivers, and television receivers in accordance with the relative importance of those branches of the art, from time to time, to the general radio industry. The figure given for the aggregate payment to Hazeltine officers and directors for the year 1946 is irrelevant since in that year the Hazeltine companies performed research and development contracts for the Armed Services and other branches of the Government aggregating more than $9,000,000. The majority of the activities of the officers of the Hazeltine companies as a whole was directed to these Government contract operations. A copy of the consolidated annual report for the Hazeltine companies for the year 1946 is attached hereto as Exhibit CC.

Par. 2(i), page 5

Mr. Woodworth's statements as to the magnitude of the Hazeltine royalties received is clearly nothing more than gossip and, in addition, it is irrelevant and grossly inaccurate. The total royalties collected by Hazeltine upon radio sales in the United States since its organization in 1924 is considerably less than half the figure given by Mr. Woodworth. Further, the mark-up between the manufacturer's selling price on which Hazeltine royalties are paid and the retail or list price is of the order of 2–1 rather than 3–1 as stated by Mr. Woodworth and the statement as to what the public may have paid is meaningless since the excess over the actual royalties is paid not to Hazeltine but to the radio manufacturers themselves, including defendant.

Par. 2(m), page 6

The deduction drawn by Mr. Woodworth from the Radiola 66 receiver produced by Radio Corporation of America in 1929 is obviously mere opinion and is grossly misleading in its conclusion. The fact is that the Radiola 66 sold for approximately $300 and while it did give reproduction which was comparable with receivers of today's standards, such receivers giving that quality of reproduction are now obtainable at prices of the order of Twenty-Five Dollars ($25). Obviously, only revolutionary changes in circuit design and circuit components could have resulted in such a revolutionary reduction in price. No more convincing proof could be offered that research and development such as Hazeltine has performed in the radio art has contributed to, rather than taken away from, the public welfare.

Par. 6(d), page 11

Mr. Woodworth's statement with respect to radio-manufacturing companies not paying Hazeltine royalties, while wholly irrelevant, is again obviously pure rumor since it is so completely at variance with the facts. There follows below the list of companies mentioned by Mr. Woodworth with the correct status of their relation to Hazeltine shown opposite each company:

Colonial Radio Corp.	Hazeltine previously in litigation with Colonial; negotiations with respect to a license now pending
Detrola Radio Corp.	Hazeltine previously in litigation with Detrola (see comment to Par. 2(e), supra)
Emerson Radio and Phonograph Corp.	Hazeltine now and for many years in litigation with Emerson
Sonora Radio Corp.	Hazeltine previously in litigation
Motorola Radio Co.	This company paid royalties through June 30, 1947, rather than through 1935 as stated by Mr. Woodworth. Renewal of its license still subject to negotiation
General Motors Corp.	Hazeltine now in litigation with General Motors (see comment to Par. 6(e), infra)
The Crosley Corp.	Hazeltine now in litigation with Crosley
Admiral Radio Co.	This company paid royalties through June 30, 1947, as stated by Mr. Woodworth. Renewal of its license still subject to negotiation

DeWald Radio Mfg. Corp. ..... This company paid royalties through 1946, rather than through 1945, as stated by Mr. Woodworth and a suit by Hazeltine on the license agreement is now pending

Noblitt-Sparks)
Stromberg-Carlson)
Wells-Gardner)
Wilcox-Gay) ..... These companies did not cease paying royalties on June 30, 1947, as stated by Mr. Woodworth, but each of them, as of that date, accepted new Hazeltine licenses for periods of from 5 to 10 years and of scope and substance substantially identical to Defendant's license here in controversy

Par. 6(e), page 12

With respect to defendant's cataloguing of the Hazeltine patents which have been invalidated, this is, of course, a matter of public record. Nevertheless, Mr. Woodworth's list is misleading in that he fails to state that the Wheeler patent Re. 19,744 was sustained by the District Court and affirmed by the Circuit Court of Appeals of the Sixth Circuit (see comment on Par. 2(e), supra), and that patents 1,951,685 and 2,041,273 are now involved in litigation with General Motors Company on appeal to the Sixth Circuit Court of Appeals. With respect to this same subject of the prosecution of suits for infringement against non-licensees, Hazeltine has for many years had a rather definite policy. It is

Hazeltine's position that it would be an undue burden, on the courts and on itself and on the radio manufacturers, simultaneously to present suits for infringement upon all of its patents being infringed by all non-licensed companies. On the contrary, it has been Hazeltine's policy to bring suits on representative patents against substantial and representative non-licensed companies with the expectation that a favorable conclusion of such suits would be dispositive of its contests with those particular companies and of its contests on that particular patent with all unlicensed companies. This procedure is, in Hazeltine's judgment, what is "reasonably necessary and prudent for enforcing those patents and preventing unlicensed competition in patented apparatus in the field of this license" (Article VIII, Section 1). Mr. Woodworth's statement that Hazeltine has threatened non-licensed manufacturers "that their customers would be subjected to harassment and intimidation" if they were unlicensed is pure rumor and gossip. This has never been the policy of Hazeltine. Hazeltine has never made any such threat and, as a matter of fact, Hazeltine has brought no suit against any customer of a radio manufacturer during the last ten years with the sole exception of a suit against Sonora Radio Corporation in Chicago, in which its customer, Allied Radio Company, also of Chicago, was joined in the same suit.

Par. 6(g)–6(ae), inclusive, pages 13–24, inclusive

This labored and verbose review of the litigation between Hazeltine and Emerson is also obviously pure hearsay. It is also irrelevant and many of the general allegations are contrary to detailed fact. The history of this prolonged litigation can be told very simply: The litigation was initiated by a suit brought by Hazeltine against The Crosley Corporation in its home town of Cincinnati, Ohio on patents 1,913,604 and 2,022,514. The District Court for the Southern District of Ohio, Western Division, held the patents not infringed and did not pass upon validity, (39 F.S. 775). The Circuit Court of Appeals for the Sixth Circuit

affirmed (130 F.(2d) 344). At about this time (December, 1940) the Sixth Circuit Court of Appeals had just found valid and infringed Hazeltine's important patent Re. 19,744 on an automatic volume control circuit widely used by the industry including The Crosley Corporation. (See comment on Par. 2(e), supra) Crosley faced a possible injunction on this important patent since its factory in Cincinnati, Ohio, is in the Sixth Circuit. At this point a jurisdictional race was precipitated by Crosley and Emerson. These companies attempted to transfer all of the Hazeltine litigation to Delaware, the state of incorporation of Hazeltine Corporation, but a state in which none of the parties had any active place of business, because of the fact that this state is encompassed in the Third Federal Circuit which Crosley and Emerson conceived to be less favorable to patents generally. Hazeltine insisted that the proper venue for the litigation with Crosley was in Cincinnati where it had its principal place of business. The District Court of Delaware agreed with Hazeltine; the Court of Appeals for the Third Circuit agreed with Crosley. During this interlocutory skirmishing, the country became at war. Hazeltine requested an adjournment of the litigation for the duration in order to maintain the status quo as it did in all of its other pending litigation without opposition. Crosley and Emerson, feeling that they had Hazeltine at a disadvantage because of its heavy commitments for war work, stubbornly resisted all attempts at deferring the trial of the cases. Finally, the Navy Department intervened and insisted that the cases be not tried. This is corroborated by a letter dated May 6, 1944, from the Honorable James Forrestal, then Under Secretary of the Navy, now Secretary for National Defense, a photostatic copy of which is attached hereto as Exhibit DD. This letter completely disposes of the many malicious inferences and innuendoes found in Mr. Woodworth's affidavit with respect to this Crosley and Emerson litigation. After the conclusion of the war, the jurisdictional race took up where it left off. The litigation with the Crosley and Emerson companies is still in its interlocutory stages. The inference that Hazeltine is avoiding litigation of its patents is nega-

tived by the fact that it pressed with the greatest urgency both its suits against General Motors on its patents 1,951,685 and 2,041,273. Those suits were tried in February of 1947, the trial consuming approximately three weeks. A decision was rendered on June 23, 1947, and appeal was filed promptly to the Sixth Circuit Court of Appeals and that appeal is now pending.

Par. 8(c), page 27

With respect to Mr. Woodworth's criticism of the Hazeltine patent marking requirements, there is attached hereto as Exhibit EE a copy of the patent license notice forwarded to all licensees on and after March 6, 1945. The Court can determine whether or not this constitutes an improper patent marking requirement. With respect to the particular patents listed by Mr. Woodworth and alleged to be improperly included on this patent marking list because of having been adjudicated invalid, the fact is that only certain claims of each of these patents were so adjudicated and that there remain in each of the patents a number of claims as to which the validity has not been adjudicated. The patents enumerated by Mr. Woodworth are listed below with the unadjudicated claims set opposite each:

1,710,035	2, 4, 9–12, incl.
1,755,114	1–9, incl., 11, 15, 18, 20, 22, 25, 26, 27, 28, 30, and 31
1,755,115	4–7, incl.
Re.19,744	8
1,913,604	non-infringement only
1,951,685	now on appeal to Sixth Circuit Court of Appeals
2,022,514	non-infringement only
2,041,273	now on appeal to Sixth Circuit Court of Appeals
2,111,483	1–27, incl. and 34

Par. 8(e)-(f), page 28 and page 29

Mr. Woodworth's sweeping allegation that Hazeltine has required companies to assign their patents to Hazeltine without charge, in addition to the payment of royalties, is obviously pure hearsay by one incompetent to testify as to the matter, since it is completely contrary to the fact. The situation is as follows:

Latour Corporation—Hazeltine Corporation purchased the entire capital stock and all the assets of Latour Corporation for a substantial consideration. There was no litigation with Latour Corporation at any time.

Atwater-Kent Mfg. Co.)
Arthur Atwater-Kent)—As a result of extensive litigation with these parties resulting in a judgment in favor of Hazeltine, very large damages and profits had accrued to Hazeltine because of the infringing sale of radio apparatus by these parties extending over a period of years. A settlement was effected under which, as partial payment of these accrued damages and profits, these parties granted to Hazeltine a license, together with the right to grant sublicenses, under the patents as listed in Schedule A of the license agreement, Exhibit A. There was no assignment of any of these patents to Hazeltine, the legal title in these patents residing in Radio Corporation of America.

Zenith Radio Corporation)
United American Bosch Corp.)—Again as to these two companies, non-exclusive license rights were acquired by Hazeltine as a partial consideration in settlement agreements terminating infringement litigation between the parties. None of the Zenith or Bosch patents were assigned to Hazeltine.

Licenses were extended under these groups of patents to all the Hazeltine licensees, including defendant, without additional charge.

Par. 8(h), page 29

The litigation referred to by Mr. Woodworth against the customers of Atwater-Kent Manufacturing Co. was brought nineteen years ago and after a final judgment against the manufacturer which was affirmed on appeal.

Par. 8(j), page 30

Mr. Woodworth refers to the Hazeltine license agreement as "oppressive". This is obviously merely his opinion, as the agreement speaks for itself. However, the radio industry as a whole has not found the agreement oppressive; in fact it has been modified from time to time to better meet the industry's desires and needs. The great majority of the large responsible manufacturers of the industry renew their licenses from time to time as they expire. (See comment to Par. 6(d), supra)

Par. 8(l), page 30

As stated hereinafter, Hazeltine Corporation has not, during the last ten or more years, sued or threatened to sue or otherwise harassed customers of any unlicensed radio manufacturing company with the single exception noted above, in which the customer was joined with the manufacturer.

Par. 8(m), page 31

Mr. Woodworth's statement as to the nature of the license of Radio Corporation of America under patents of Hazeltine relating to tubes, is obviously hearsay as it is specifically contrary to fact. The license under the Hazeltine patents to Radio Corporation of America relating to tubes is limited to what is generally known in the art as "replacement" tubes. It specifically excludes tubes sold as original equipment in radio receivers by licensed manufacturers. Further, the royalty specified in the agreement is on the whole receiver as sold to the user; not on the tubes, per se.

JOHN R. BINNS

Sworn to and subscribed before me this tenth day of February, 1948.

OLGA J. OSTERLUND,
Notary Public.

Commission Expires March 30, 1949

[SEAL]

March 6, 1945

EXHIBIT EE ATTACHED TO AND FORMING PART OF AFFIDAVIT OF JOHN R. BINNS IN OPPOSITION TO DEFENDANT'S COUNTER-MOTION FOR SUMMARY JUDGMENT IN CIVIL ACTION 6677.

Licensed by Hazeltine Corporation only for use in homes, for educational purposes, and for private, non-commercial use, under one or more of the following patents and under pending applications:

Patent			
1,697,778	1,913,604	2,036,319	2,099,156
1,710,035	1,915,926	2,038,294	2,100,402
Re.17,531	1,920,743	2,039,136	Re.20,632
1,751,854	1,921,087	2,041,273	2,111,483
1,755,114	1,927,672	2,041,291	2,137,123
1,755,115	1,931,338	2,042,571	2,137,266
1,763,380	1,933,402	2,045,910	2,137,318
1,773,573	1,934,940	2,048,528	2,148,633
1,798,962	1,943,405	2,054,424	2,152,470
1,810,355	1,951,685	2,064,774	2,167,136
1,828,688	1,958,027	2,064,775	2,196,881
1,833,085	Re.19,170	2,072,679	2,208,382
1,845,306	2,007,253	2,072,708	2,211,718
1,855,055	2,015,327	2,073,038	2,216,874
1,857,055	2,016,760	2,073,345	2,222,387
1,877,228	Re.19,744	2,080,560	2,250,862
1,887,329	2,021,692	2,080,646	2,273,709
1,888,278	Re.19,765	2,081,861	2,279,543

1,904,185	2,022,067	Re.20,400	2,284,131
1,906,106	2,022,514	2,089,270	2,294,182
1,908,119	2,026,075	2,092,709	Re.22,195
1,910,399	Re.19,823	2,093,416	

EXHIBIT CC ATTACHED TO AND FORMING PART OF AFFIDAVIT OF JOHN R. BINNS IN OPPOSITION TO DEFENDANT'S COUNTER-MOTION FOR SUMMARY JUDGMENT IN CIVIL ACTION 6677.

HAZELTINE CORPORATION

To the Stockholders:

The Report of your corporation for the year ending December 31, 1946, follows:

Income

Net earnings of Hazeltine Corporation and its subsidiary companies for the year 1946 are shown on the Consolidated Income and Expense Statement in this report. Re-negotiation for the year 1945 was completed and no refund was required.

Dividends

Distributions aggregating $1.25 per share were made to stockholders during 1946. We are advised by Accountants and Counsel that in their opinion, based on the enclosed statement, the dividends distributed last year were paid out of current income and earned surplus.

New Operating Subsidiaries

In order to meet changing conditions in the industry and more adequately serve the licensees, two wholly owned subsidiary companies were organized during the year. The first of these was Hazeltine Research, Inc., incorporated under the laws of the State of Illinois. All United States Letters Patent and pending applications for U. S. Letters Patent owned by your company were assigned to Hazeltine Research, Inc. In addition, all license agreements with manufacturers in the United States, as well as the lab-

oratory located at 325 West Huron Street, Chicago 10, Illinois, were transferred to it.

The second wholly owned subsidiary to be formed was Hazeltine Research, Inc. of California, a corporation organized under the laws of the State of Delaware. This company has obtained a franchise to do business in the State of California. It has started a laboratory which is being equipped in leased premises at 2120 North Cahuenga Boulevard, Los Angeles, California.

Engineering

During the year 1946, the scientific, engineering and technical staffs of your companies were stabilized at some 450 persons including graduate engineers, supporting personnel and facilities. They were divided into three groups functioning as follows:

Group I is engaged in advance development on home broadcast receivers and television, including the maintenance of licensee laboratories at New York and Chicago. Steps were taken to open a third licensee laboratory in Los Angeles early in 1947. These laboratories cooperate with Hazeltine licensees located in the East, Central and Western industrial areas of the country in respect to current design, development and production problems.

Group II is engaged in research, development and limited production of projects of military significance to the Armed Services of the United States. This is a continuation of the type of work undertaken by Hazeltine for the United States Government during the war.

Group III is engaged in research and development in the field of marine and air navigation, all-weather flying and nautical and aeronautical traffic control.

Hazeltine Lanac Safety System

Based upon wartime developments, Hazeltine engineers have created a unique system of traffic control including identification and anti-collision means, which has immediate application in both marine and air operations. By the proper application of this sys-

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TRADE MARK ®

1679

MATTHEW BENDER & COMPANY
MB

49

tem, movements of both marine and air traffic can be accelerated in unfavorable weather, and the safety factor improved to that corresponding to good weather conditions.

The new system has been called Lanac, meaning Laminar Air Navigation Anti-Collision. Demonstrations of Lanac and another Hazeltine development referred to as Distance Measuring Equipment (DME), were conducted in cooperation with the All-Weather Flying Group of the Army Air Forces before the PICAO (Provisional International Civil Aviation Organization) convention held at Indianapolis from October 10th to October 23rd, 1946. The convention was attended by representatives of 46 nations interested in a solution of the problem of air navigation, anti-collision and traffic control.

Hazeltine demonstrated its systems by means of equipment installed in five planes. During the demonstrations more than 100 flights were made, involving over 100,000 passenger miles. Repeated landings were made in a hooded or covered cockpit at intervals of one minute (about three miles), which is about the same interval employed in bright clear weather. This is an improvement of many times that heretofore considered practical under such adverse conditions. These successes were achieved as a result of the complete information continuously available to the pilots through the instrumentality of the Hazeltine electronic equipment.

The practical utilization of these systems, or any portion of them, will depend upon the decisions of the various Aviation Control Authorities in each country including those of the United States Government.

Litigation

The group of suits brought prior to the War against a large Midwestern manufacturing company to enforce a number of your company's patents, which it was expected would be tried in October, 1946, were postponed by events beyond our control. The trial has now been set for February, 1947. The two Declaratory Judgment actions to test the validity and scope of your company's patents, which were filed in the United States District Court of

Delaware the latter part of 1945, are still pending but are in the interlocutory stage.

Review

During the year, approximately fifteen and a half million radio receivers of various types were sold by the industry. This exceeds the total sales of any previous year by two million sets. Of the total units sold last year, more than fifty per cent were of the table model type as against the pre-war range of twenty-seven per cent for table models. Various shortages, particularly wooden cabinets, limited the sale of medium and high price units.

Television receiver sales did not get started until the end of the year. A total of 6,500 sets were sold and of these 3,500 were sold during December. Construction permits for F. M. and Television broadcasting transmitters granted by the Federal Communications Commission during the year should contribute to the demand for the types of receivers capable of reproducing these services, since a large number of additional stations will commence transmissions early in 1947. Various manufacturers estimate the sales of television receivers during 1947 will reach approximately 300,000 sets.

Toward the end of 1946, as full production was reached, competition became keen, particularly in the smaller units. There is every indication the competitive pressure will increase in all types during 1947.

EDGAR RICKARD, Chairman
JACK BINNS, President

Hazeltine Corporation
and its wholly owned subsidiaries

Consolidated Balance Sheet as at December 31, 1946

Assets

Cash in banks and on hand (including $132,651.02 advanced by United States Government

for specific contracts and $108,-877.46 on deposit in bank in Canada)		$2,859,357.31
Accounts receivable arising from Government and other contracts, royalties receivable and accrued		1,207,162.05
Costs incurred on uncompleted portion of contracts not billed		1,962,066.47
Termination claims filed with the Government less partial payments received		1,322,511.98
Total current assets		$7,351,097.81
Land, buildings and equipment at cost	$ 586,022.18	
Less provision for depreciation and amortization	423,620.64	162,401.54
Investments in and advances to affiliated companies		315,632.92
Prepaid expenses, advances and sundry accounts receivable		56,496.42
Patents, patent rights and inventions at cost, less provision for amortization		403,162.91
		$8,288,791.60
Liabilities		
Accounts payable and accrued expenses		$ 626,987.80
Payroll deductions for income tax withheld and Government bonds		34,191.07

Advance payments by United States Government		3,057,737.99
Provision for Federal taxes on income	$ 645,666.34	
United States Treasury Notes, Series C (principal amount)	250,000.00	395,666,34
Total current liabilities		$4,114,583.20
Royalties paid in advance		52,500.00

Capital

Capital stock:		
Authorized 600,000 shares, no par value		
Issued and outstanding 350,000 shares	$2,577,434.16	
Distribution made to stockholders from provision for amortization of patents	$ 444,353.83	
Earned surplus after amortization charges		
Balance, December 31, 1945	$1,539,130.50	
Net income for year 1946	886,432.34	
Unclaimed dividends	565.23	
	$2,426,128.07	
Dividends paid during 1946	437,500.00	
Balance, December 31, 1946	$1,988,628.07	
Capital and surplus		4,121,708.40
		$8,288,791.60

Hazeltine Corporation
and its wholly owned subsidiaries

Consolidated Income and Expense Statement for the Year Ended December 31, 1946

Income		
Gross income from sales, less costs applied thereto, domestic and foreign royalties and engineering services		$2,001,732.32
Other income		22,618.00
Total income		$2,024,350.32
Expenses other than those charged directly to cost of products		
Salaries, laboratory and office	$1,053,366.29	
Legal and accounting fees	82,815.40	
Rent	26,351.91	
Taxes other than Federal taxes on income	89,713.09	
Provision for depreciation of furniture, equipment and laboratory building	17,657.47	
Agency services	4,285.95	
Other operating expenses including materials and supplies, telephone and telegraph, insurance, traveling, stationery and supplies and other expenses	300,323.33	
	$1,574,513.44	

Less amount applied to cost of services, product shipped and uncompleted contracts	1,086,099.70	
	$ 488,413.74	
Provision for amortization of patents	57,504.24	
Provision for Federal taxes on income	592,000.00	1,137,917.98
Balance carried to surplus		$ 886,432.34

Frazer and Torbet
CERTIFIED PUBLIC ACCOUNTANTS
230 PARK AVENUE
NEW YORK 17

CHICAGO
MILWAUKEE
TULSA
HOUSTON
WASHINGTON, D. C.

CABLE ADDRESS
FRAZTOR CHICAGO

February 19, 1947

Messrs., The Board of Directors
Hazeltine Corporation
National Press Building
Washington, D. C.

HAZELTINE CORPORATION

REPORT OF AUDIT
AS AT DECEMBER 31, 1946

Gentlemen:

We have examined the consolidated balance sheet of Hazeltine Corporation, a Delaware corporation, and its wholly owned subsidiaries, Hazeltine Electronics Corporation (New York), Hazeltine Research, Inc. (Illinois), Hazeltine Research, Inc, of California (Delaware) and Latour Corporation (Delaware) as at December 31, 1946, and the consolidated statement of income and

expense for the year ended that date, have reviewed the system of internal control and accounting procedures of the companies and, without making a detailed audit of the transactions, have examined or tested accounting records of the companies and other supporting evidence by methods and to the extent we deemed appropriate. Except that it was not practicable to confirm receivables from the United States Government, as to which we have satisfied ourselves by means of other auditing procedures, our examination was made in accordance with generally accepted auditing standards applicable in the circumstances and included all procedures which we considered necessary.

In our opinion, the accompanying balance sheet and related statement of income and expense fairly present the consolidated position of Hazeltine Corporation and subsidiaries at December 31, 1946, and the results of their operations for the calendar year ended that date in conformity with generally accepted accounting principles maintained by companies on a basis consistent with that of the preceding year.

Faithfully yours,

FRAZER AND TORBET,
Certified Public Accountants

Hazeltine Electronics Corporation
1775 Broadway
New York 19, N. Y.

Directors
For the Year 1946
Edgar Rickard, Chairman

Paul Armitage	William H. Grimditch
Jack Binns	W. A. MacDonald

Officers

Edgar Rickard	Chairman of the Board
W. A. MacDonald	President
William H. Grimditch	Executive Vice President
Jack Binns, L. B. Dodds, Fielding Robinson	Vice Presidents
John D. Grayson	Treasurer
Lincoln De Graw	Controller
Paul Armitage	Secretary
Peggy Coyle, Carl Di Martino, Wilfred M. McFarland, Olga J. Osterlund	Assistant Secretaries

---

Hazeltine Research, Inc.
325 West Huron Street
Chicago 10, Illinois

Directors
For the Year 1946

Paul Armitage — L. B. Dodds
Jack Binns — William H. Grimditch
W. A. MacDonald

Officers

Jack Binns	President
L. B. Dodds	Executive Vice President
William H. Grimditch, W. A. MacDonald	Vice Presidents
Paul Armitage	Secretary
John D. Grayson	Treasurer
Wilfred McFarland, Harry C. Page	Assistant Secretaries

Registrar
City Bank Farmers Trust Company
New York

Transfer Agent
Chase National Bank
New York

listing
New York Curb Exchange

Hazeltine Corporation

Directors
For the Year 1946

Edgar Rickard, Chairman

Paul Armitage	H. Elbert Foster, Jr.
Jack Binns	William H. Grimditch
L. B. Dodds	W. A. MacDonald

Henry Reeve

Officers

Edgar Rickard	Chairman of the Board
Jack Binns	President
W. A. MacDonald	Vice President & Chief Engineer
William H. Grimditch	Vice President
L. B. Dodds	Vice President
Paul Armitage	Secretary
John D. Grayson	Treasurer
Wilfred M. McFarland, Harry C. Page	Assistant Secretaries

THE UNDER SECRETARY OF THE NAVY
WASHINGTON

6 May 1944

MAY 9 1944

Re: Crosley Radio Corporation
vs
Hazeltine Corporation

Emerson Radio and Phonograph Corp.
vs
Hazeltine Corporation

Dear Mr. MacDonald:

I understand that the actions and cross actions referred to above which have been pending in the District Court of the United States in the District of Delaware have been dismissed. Since the termination of these actions was made possible by Hazeltine Corporation's acceding to the Navy Department's request that Hazeltine waive its claims for profits and damages under its cross actions, I would like to record briefly the reasons for the Navy's request and to express our appreciation for the action which your Company has taken.

As I understand it, the litigation concerned peacetime activities of the plaintiffs and of your Company and involved matters having an important bearing on their and your postwar activities. The actions were instituted sometime ago for a declaration that certain of your Company's patents, which you advised me were most important to your Company's peacetime operations, were invalid and were not infringed by the plaintiffs. In your cross actions you contended that the patents were valid and had been infringed by the plaintiffs and you requested that you be awarded the profits and damages to which you were entitled because of such infringement.

I realize that it was to the interest of both your Company and the plaintiffs to have these actions tried at the earliest possible date so that their respective positions in the industry would be clarified before peacetime production involving the patents was resumed. However, Hazeltine Corporation's participation in the electronics program of the Navy and Army and our Allies is so vital that the devotion of time by your engineers to the case would have seriously impaired our war work. At the Navy's request the action was postponed last year but a recent application for further postponement was denied by the Court. The Plaintiffs refused to consent to any further postponement.

Although I was in no position to determine the relative merits of the actions or the cross actions, you did explain to me the importance of the litigation to your Company and the necessity for your requiring certain of your key engineers to devote all or a portion of their time to preparation for the trials. I was vitally interested, however, in seeing that the litigation did not affect our war program and I therefore personally appealed

Exhibit DD attached to and forming part of Affidavit of John R. Binns in Opposition to Defendant's Counter-Motion for Summary Judgment in Civil Action 6677

to you and requested that, in order to obtain a dismissal of the actions, your Company waive its right to the past profits and damages which might accrue to it if it were successful in its cross actions.

While I realize that this was asking you and your company to relinquish certain private rights to which you might have been entitled and that I could not insist that this be done, I do want to assure you that I was most sincere in my statement that the war effort would have been seriously impeded had the actions gone to trial and resulted in the loss to our vital electronics program of your Company's engineers, who are now and have been spending all of their time on our work, the importance of which you fully understand.

The dismissal of the actions eliminates the possibility of such a loss and I cannot adequately express how deeply this is appreciated by the Navy Department.

Sincerely yours,

James Forrestal

James Forrestal

Mr. W. A. MacDonald, President
Hazeltine Corporation
1775 Broadway
New York 19, New York

AFFIDAVIT OF LAURENCE B. DODDS IN OPPOSITION TO DEFENDANT'S COUNTER-MOTION FOR SUMMARY JUDGMENT.

[Filed February 11, 1948.]

State of New York)
) ss.:
County of New York)

Laurence B. Dodds, being duly sworn, deposes and says:

1. That I am an attorney at law and of counsel for plaintiff in the above-entitled action.

2. I have read affidavit of George K. Woodworth in support of defendant's counter-motion for summary judgment and particularly paragraph 7(b) at page 26 thereof.

3. I was present during the entire conference referred to by Mr. Woodworth in the aforesaid affidavit, which conference was held in the office of Richard F. Walker, attorney for plaintiff in the above-entitled action, and which was attended also by Mr. David Housman, President of defendant company.

I state categorically that I did not make the statement attributed to me by Mr. Woodworth in Paragraph 7 (b) of his aforesaid affidavit, nor did I make any statement of similar import or to similar effect.

4. On the contrary, at the aforementioned conference, I explained in detail to Mr. David Housman, President of defendant, that Hazeltine had been in the licensing business for some 23 years and that it was dependent entirely for its existence on the income from such licenses in the radio industry; that, as a result, it realized that its license must be a reasonable business proposition mutually advantageous to both licensor or licensee or else it would not be able to continue in business; that Hazeltine considered that its present license agreement was such a reasonable business deal since it involved, for a consideration averaging less than one per cent. (1%) of the licensee's sales a package containing the following elements:

(a) Protection under the broad and basic patents of Hazeltine

(b) Freedom of design under the large number of improvement patents relating to different features of different types of radio receivers

(c) Substantial and valuable general and individual engineering services and

(d) Freedom from litigation expenses

LAURENCE B. DODDS.

Sworn to and subscribed before me this tenth day of February, 1948.

OLGA J. OSTERLUND,
Notary Public.

Commission Expires March 30, 1949

[SEAL]

AFFIDAVIT OF RICHARD F. WALKER IN OPPOSITION TO DEFENDANT'S COUNTERMOTION FOR SUMMARY JUDGMENT.

[Filed February 11, 1948.]

Commonwealth of Massachusetts:
County of Suffolk : ss.

Richard F. Walker, being duly sworn, deposes and says:

1. I am an attorney at law with an office at 31 Milk Street, Boston 9, Massachusetts.

2. I have read the affidavit of George K. Woodworth executed January 30, 1948 and served herein in support of defendant's countermotion for summary judgment, and particularly its Paragraph 7(b) at page 26 thereof relating to a statement allegedly made by Mr. L. B. Dodds at a conference held on July 22, 1947. I was present throughout said conference which was held in my office and attended by Mr. David Housman, defendant's President, Mr. Woodworth, Mr. Dodds and myself, and I state cate-

gorically that Mr. Dodds did not make the statement attributed to him in said Paragraph 7(b). To the contrary, the statements of Mr. Dodds at said conference were in substance that the patents licensed by plaintiff to defendant included some which were used commercially by defendant and which were of substantial value, and that the royalty rate charged in the license was reasonably set and fully justified. I am not familiar with the subject matter of the particular patents here involved, but I know there was substantial discussion at said conference between Mr. Dodds and Mr. Woodworth as to whether defendant's commercial structures embodied the subject matter of certain of the licensed patents with several references to some tube which they referred to as a "variable Mu".

3. The net result of said July 22 conference was that Mr. Woodworth was again to take up with Mr. Irving Wexler, an expert engineer employed by defendant, the question of how far defendant's commercial products embodied licensed subject matter as set out in Mr. Dodds' answers to defendant's interrogatories previously filed herein. In that late afternoon of July 22, 1947 I received from Mr. Woodworth a telephoned message for Mr. Dodds which I relayed on to him on July 23 as follows:

> "Dear Mr. Dodds:
>
> Following your departure last night, Woodworth called and, finding you gone, requested me to give you the following message.
>
> That he now finds he misquoted his expert on the Mu tubes when he referred to them as mixing tubes. What he should have identified was the variable Mu detector tube and in respect to the Johnson patent claims 18 and 20.
>
> As I understand it, it is this detector tube of the Johnson patent claims which does not occur in the accused structures, according to the contention of his expert.
>
> * * * * * * * * *".

Later on July 29, 1947 I received and reported to Mr. Dodds the

letter to me from Mr. Woodworth dated July 28, 1947, a copy of which is annexed hereto.

4. That on August 6, 1947 I received a call from Mr. Woodworth during which he urged the desirability of the conference of experts proposed by him in his said letter of July 28, and on August 7, 1947 I reported as follows to Mr. Dodds—as I believe accurately— of Mr. Woodworth's statements as made to me on the preceding day:

> "Among other things he" (Mr. Woodworth) "urged the desirability of the conference, with a statement that if your expert could convince Mr. Wexler that Defendant's production came within any one of the licensed claims, either with or without the use of the doctrine of equivalents, Defendant was prepared to change its position and pay up back rated royalty in exchange for your kind offer to waive the minimum royalty obligation."

5. Subsequently arrangements were made for said conference to be held in New York upon September 22, 1947, and arrangements were made with this Court to postpone or "continue" pretrial herein until after this attempt at settlement was exhausted. By this time, however, Samuel E. Darby, Jr., Esq. had come in as counsel for defendant, and we were advised on September 16, 1947 by Mr. Woodworth that Mr. Darby declined to proceed with the proposed conference of experts and the arrangements therefor were consequently cancelled.

6. That it is only subsequent to the foregoing activities and on September 18, 1947 that defendant claims, as set out in Paragraph 11, page 34 of Mr. Woodworth's said affidavit, to have repudiated its license from Hazeltine.

RICHARD F. WALKER.

Subscribed and sworn to before me this ninth day of February, 1948.

JOHN D. WOODBERRY,
Notary Public.

[SEAL]

275

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PATENTS, TRADE MARKS, COPYRIGHTS

WASHINGTON OFFICE:
NATIONAL PRESS BLDG

GEORGE K. WOODWORTH
COUNSELLOR AT LAW
19 CONGRESS STREET, BOSTON 9, MASS.

July 28, 1947

Richard F. Walker, Esq.
Roberts, Cushman & Grover
31 Milk Street
Boston 9, Massachusetts

Re: Hazeltine v. Automatic Radio, C.A. No. 6677

Dear Mr. Walker:

I enclose substance of my report to Automatic Radio Mfg. Company, Inc. based on conferences with Automatic's expert, as corrected, after the final conference last week.

I think we ought to have a conference between Automatic's expert and the engineer who gave Mr. Dodds the data for his answers to defendant's interrogatories. In such case, the attorneys for both parties could sit in and say nothing except possibly ask questions. The court would, I am sure, be duly appreciative if we could limit this case to the three Wheeler patents mentioned at the end of the enclosed memo.

As you know, of course, the royalties collectible if all 11 patents and their 52 claims were made good would not be one penny greater than those recoverable if claim 3 of Wheeler 1958,027 were found valid and infringed.

I suggest you take this matter up with Mr. Dodds for whom a duplicate of this letter is enclosed.

Very truly yours,

GKW:B

AFFIDAVIT OF CHARLES R. WEXLER IN REBUTTAL TO THE "AFFIDAVIT OF JOHN R. BINNS IN OPPOSITION TO DEFENDANT'S COUNTERMOTION FOR SUMMARY JUDGMENT," SAID AFFIDAVIT HAVING BEEN SERVED FEBRUARY 11, 1948.

[Filed February 12, 1948.]

Commonwealth of Massachusetts,
Suffolk, ss.

Charles R. Wexler, being first duly sworn, deposes and says:

I am a graduate of the Massachusetts Institute of Technology and for many years have been associated in an engineering capacity with the radio industry. I am now and for some time past have been chief engineer of defendant, Automatic Radio Manufacturing Company, Inc.

On this day, February 12, 1948, at the request of George K. Woodworth, attorney for defendant, I purchased from Eastern Company at 620 Memorial Drive, Cambridge, Massachusetts, the Massachusetts distributor of RCA Victor Sales & Service, (see Boston Classified Telephone Directory, December, 1947, p. 624) a wholly owned subsidiary of Radio Corporation of America, a radio tube ordinarily known as a "mixing tube", type 12SA7, which was enclosed within a paper carton. Said carton, marked A, is annexed hereto and made a part hereof, and said tube is marked B and made a part of this affidavit .

Enclosed within said carton was a card reading:

License And
Patent Notice

"This tube uses inventions of United States patents owned by or licensed to Radio Corporation of America. Patent numbers supplied upon request. Licensed for all purposes except public service communications for hire or toll. The sale of this tube does not convey any license under patent

claims on combinations of the tube with other devices or elements."

Said card, marked C, is annexed hereto and made a part hereof.

CHARLES R. WEXLER.

Subscribed and sworn to before me, this twelfth day of February, 1948.

MARGARET B. BUDDEN,
Notary Public.

[SEAL]

12SA7

YOUR PROTECTION

THIS ELECTRON TUBE IS WARRANTED BY THE MANUFACTURER AGAINST DEFECTS IN WORKMANSHIP, MATERIALS AND CONSTRUCTION.

Should you feel that this tube has not given satisfactory service under normal operating conditions, please return it to the place of purchase for retest.

LICENSE AND PATENT NOTICE

This tube uses inventions of United States patents owned by or licensed to Radio Corporation of America. Patent numbers supplied upon request. Licensed for all purposes except public service communications for hire or toll. The sale of this tube does not convey any license under patent claims on combinations of the tube with other devices or elements.

AFFIDAVIT OF FLOYD H. CREWS IN REPLY TO LAST PARAGRAPH OF THE OPPOSING AFFIDAVIT OF MR. JOHN R. BINNS.

[Filed February 13, 1948.]

State of New York,)
(ss.:
County of New York,)

Floyd H. Crews, being first duly sworn, deposes and says:

1. I am an attorney at law and am counsel for the defendant in this action.

2. On page 13 of Mr. Binn's opposing affidavit, he makes the following statement:

> "The license under the Hazeltine patents to Radio Corporation of America relating to tubes is limited to what is generally known in the art as 'replacement' tubes. It specifically excludes tubes sold as original equipment in radio receivers by licensed manufacturers."

3. I am informed and believe that Radio Corporation of America holds two licenses under the Hazeltine patents: one known as a "home" license and the other as a "commercial" license, and that the "home" license is identical with the license agreement between plaintiff and defendant (Exhibit A attached to the complaint), including the definitions contained in Article III, Section 2, of that agreement. I am further informed and believe that it is under the "commercial" license that RCA is licensed by Hazeltine to sell tubes to radio manufacturers, and that the specific provision of said "commerical" license reads as follows (the words " 'home' license" in the provision referring to the "home" license from Hazeltine held by RCA):

> "Provided that the license granted under this Section 1 shall extend to tubes sold to others by RCA, its subsidiary and controlled companies, for use in apparatus of the kinds specified in said Article III, Section 2, of said 'home' license,

but shall not extend to tubes actually licensed under said 'home' license agreement or under any license granted by Hazeltine to others for the apparatus specified in said Article III, Section 2."

It will be seen from this wording that RCA holds an unrestricted license from Hazeltine to sell radio tubes to radio manufacturers without any limitation to what Mr. Binns refers to as "replacement" tubes.

4. I have not seen either of the licenses from Hazeltine to RCA, but if any interpretation of either or both of those licenses is involved, the licenses should be produced by Hazeltine. If they are not produced, the foregoing quotation, being the only definite language taken from either license which is before the court, should be accepted as a correct quotation from the license and the above explanation as a correct explanation.

5. Furthermore, even if Hazeltine's license to RCA granted RCA a license to sell the tubes, but contained a limitation as to the use to which purchasers of those tubes could put them, that limitation would be invalid under the law quoted in defendant's brief on its counter-motion for summary judgment. The limitation would have no force and effect as against defendant, who, by the purchase of tubes from RCA, would have a license from Hazeltine to use them for any purpose. Such a restriction on re-use, furthermore, if contained in that license agreement, would constitute a misuse of patents, for the reasons explained at length in defendant's brief on its motion.

FLOYD H. CREWS.

Sworn to and subscribed before me this eleventh day of February, 1948.

EILEEN LAMERSON,
Notary Public.

[SEAL]

Commission Expires March 30, 1948

AFFIDAVIT OF FLOYD H. CREWS IN REPLY TO PAGES 8, 9 AND 10 OF THE OPPOSING AFFIDAVIT OF JOHN R. BINNS.

[Filed February 13, 1948.]

State of New York
County of New York, ss:

Floyd H. Crews, being first duly sworn, deposes and says:

1. I am an attorney at law and am counsel for the defendant in this action.

2. Attached hereto are copies of four letters which are true copies of letters written by Captain J. B. Dow of the United States Navy and Mr. Samuel E. Darby, Jr., which I am informed and believe correctly recite the facts with respect to postponing the trial of the Crosley and Emerson declaratory judgment suits brought against Hazeltine in 1941 and the ultimate dismissal of those suits.

FLOYD H. CREWS.

Sworn to and subscribed before me this twelfth day of February, 1948.

EILEEN LAMERSON,
Notary Public.

[SEAL]

Commission Expires March 30, 1948

NAVY DEPARTMENT
Bureau of Ships
Washington, D. C.

10 August 1943

Dear Mr. Darby:

This will acknowledge receipt of your letter of 28 July 1943 in which you confirm the decision of your clients, The Crosley Corporation and Emerson Radio and Phonograph Corporation, made

at my request, to consent to a postponement of their declaratory judgment suits against the Hazeltine Corporation.

In accordance with my understanding, you will review the matter with me again in January 1944 with a view to proceeding with the trial in May 1944, if possible, consistent with the war effort of the Hazeltine Corporation.

The courtesy of your clients in complying with my request is greatly appreciated and I feel, without reservation, the action is a direct and substantial contribution to the war effort.

Very respectfully yours,

(Sgd) J. B. Dow,
Captain, U. S. N.

Mr. Samuel E. Darby, Jr.,
Darby & Darby
Chrysler Building
405 Lexington Avenue
New York, N. Y.

NAVY DEPARTMENT
Bureau of Ships
Washington, D. C.

23 August 1943

Dear Mr. Darby:

This will acknowledge receipt of your letter of August 19 relating to the declaratory judgment suits against Hazeltine Corporation.

I understand that you are preparing with counsel for Hazeltine a stipulation providing for proceeding with the trial in May 1944 or as soon thereafter as the court calendar permits. This is in accordance with my understanding at the close of the last conference which you attended in my office. I will do everything possible to permit this end to be accomplished. It was, however, my under-

standing that we would meet in January to see what, if anything need or could be done to insure that the May date would be met.

Very respectfully,

(Sgd) J. B. Dow,
Captain, U. S. N.

Mr. Samuel E. Darby, Jr.,
Darby & Darby
Chrysler Building
405 Lexington Avenue
New York, N. Y.

DARBY & DARBY
Chrysler Building
New York 17, N. Y.

January 20, 1944

Captain J. B. Dow
Navy Department
Bureau of Ships
Washington, D. C.

Re: *Crosley* v. *Hazeltine*,
Emerson v. *Hazeltine*.

Dear Captain Dow:

With reference to the above litigations pending in the United States District Court for the District of Delaware, and with which you are familiar, I find a notation in my diary that, according to plan, I was to communicate with you at about this time for the purpose of ascertaining the status of the Navy-Hazeltine relations in so far as is concerned its bearing on the prospective trial of the above cases in May.

I find I must be in Washington in the Department of Justice the morning of Thursday, January 27th, and I am writing to inquire whether or not it would be convenient for you to see me in con-

nection with the above subjects matter on the aforenoon of that day and, if so, what time would be most convenient to you.

Sincerely,

(Sgd) S. E. DARBY, JR.

Jr:EL

DARBY & DARBY
Chrysler Building
New York 17, N. Y.

January 28, 1944

Alden D. Redfield, Esq.
The Crosley Corporation
Cincinnati, Ohio

Re: *Crosley* v. *Hazeltine*

Dear Alden:

As a result of my letter of January 20th to Captain Dow, a copy of which I sent you, I was notified by Captain Dow to confer with him yesterday at 2 P.M.

Accordingly I went to his office at the appointed time and, quite to my surprise, he was ready and waiting for me attended by the red haired Lieutenant Commander (now a Commander)—the one who used to be in Houget's office)—Wright (a civilian), Vanderstucken, and a new face—Captain Shea, who weighs about 200 pounds and is a very affable but hardboiled, rough and ready type of fellow.

Contrary to what Vanderstucken had implied when he saw me recently at my office, the meeting started off with the statement that the Navy was in a worse position and deeper in the hole with respect to Hazeltine than it was before. Captain Shea then spoke up and said that the Navy just could not let this litigation go on and that he would "testify" in Court and would tell any Judge that the Navy would not permit the case to go on.

I believe that he spoke out of turn because I seized upon his statement immediately and stated that that was quite agreeable

to me and would relieve me of considerable embarrassment because it converted the matter from the basis on which we originally had been approached to one in which the Navy was going to tell the Federal Court what it could or could not do; and inasmuch as I, as an attorney, was an officer of the Court I would, of course, be entirely amenable to any order of the Court entered pursuant to the Navy, or Captain Shea, telling the Court what it could and could not do. It was somewhat amusing to see how the remainder of the gentlemen present backed away from any type of support, implied or expressed, for Captain Shea's attitude.

Thereupon the Commander approached the matter from the viewpoint that the Navy was not interested in Hazeltine in any respect, except in so far as the war needs were concerned. I told him I had an entirely different impression and therefore would welcome open mindedly any thoughts that he cared to advance as to procedure at this time which would indicate, to me at least, a support for his assertion.

The thought was then advanced as to what my attitude would be to a further postponement. I stated that I was not prepared to consider it and that so far as I was concerned the case was going to be set for trial as soon after the first of May as the Court's time would permit.

The next approach was a review of what transpired at our last meeting. It was recalled that at that time someone—it was their impression that I was the one—had made the suggestion that a logical way to dispose of the matter would be to have Hazeltine give us a complete quitclaim for past infringement. In other words, if after the war Hazeltine was of the opinion that we infringed any patents still alive, Hazeltine could institute a suit against us on those patents at that time.

I stated that I definitely recalled the suggestion and its vigorous refusal by Hazeltine, but that as I recalled it the suggestion had one additional attribute which they had not mentioned, namely that if at the end of the war Hazeltine determined to sue us for

infringement of any of the patents involved in the present case, we should be notified thereof in sufficient time to permit us to file a suit for declaratory judgment in the Delaware District Court with respect to any patents involved in the present case, to thereby retain the status quo, jurisdictionally, of any patent of Hazeltine involved in the present suit. That proposition was first vigorously contested by the Commander, which occasioned me to comment that he could see what I meant by questioning, in my own mind, the neutral attitude of the Navy with respect to the litigants. I asked him to point out in any respect in which the foregoing condition was unfair to Hazeltine. I stated, quite frankly, that I was very well satisfied with the present jurisdiction of the Court, and Hazeltine was equally as well dissatisfied, and that inasmuch as the matter of jurisdiction had already gone as far as the Supreme Court there was no power—certainly in Hazeltine or the Navy—that could disturb the jurisdictional feature, and that I had not the slightest intention, by agreement or otherwise, to permit it to be disturbed.

The inability of the Commander to point out a single phase of the proposition which was eminently unfair quickly resulted in the expression that it was fair. Whereupon the matter was left with Captain Dow's group to consider the matter and explore it with Hazeltine, with the idea of the Navy bringing its influence to bear upon Hazeltine in its consideration thereof. Again the rough and ready Captain Shea came to the fore with the characteristically forceful expression that the Navy would *tell* Hazeltine what it would and what it would not do.

That is the way the matter stands. In no sense are we committed, although it may well be that the Navy group will assume that we are notwithstanding the fact that I took particular pains to state I had not discussed the offer with my clients since it was originally made and rejected. However, if the Navy should come back (and it intends to let me know very shortly) with the information that the litigations (both in Delaware and Ohio) can be disposed of on that basis, I would strongly recommend that

this be done despite my strong personal inclination to be contrary, because undoubtedly it would be for the best interests of the clients.

I will keep you fully advised as to any developments.

With warm personal regards, I am

Very truly yours,

(Sgd) S. E. DARBY, JR.

AFFIDAVIT OF LAURENCE B. DODDS.

[Filed February 13, 1948.]

Commonwealth of Massachusetts)
) ss.
County of Suffolk)

Laurence B. Dodds, being duly sworn, deposes and says:

1. That he is of counsel for plaintiff in the above entitled action and is also an officer of plaintiff and completely familiar with its license agreements and particularly with two certain license agreements with Radio Corporation of America executed and dated as of December 15, 1937, and identified as the "Commercial" license and the "Home" license respectively and that he participated in the negotiation of those licenses with Radio Corporation of America and the drafting of the formal license documents.

2. That the aforesaid "Home" license of Radio Corporation of America is in standard printed form substantially identical to the standard license agreement held by defendant herein and attached to the complaint and marked Exhibit A and that Article II, Section 2 of aforesaid "Home" license of Radio Corporation of America, defining apparatus of the type licensed, is exactly identical to Article III, Section 2 of said license agreement with defendant, the difference in the numbering of the articles in two agreements being accounted for by the inclusion in the said license of defendant as Article I of a clause entitled "Settlement of

Damages" which clause is however crossed out in defendant's license.

3. That aforesaid "Commercial" license of Radio Corporation of America includes the following clause:

"Article I

Licenses

Section 1. Hazeltine hereby grants and agrees to grant under all United States Letters Patent of Schedule A and under all the United States Letters Patent to issue on the applications of Schedule A and under all other United States Letters Patent and applications relating to or applicable to radio communication, wire communication, sound and picture recording and reproducing and tubes and tube circuits with respect to which during the term hereof it shall have the right to grant licenses (but in the case of patents and applications under which Hazeltine has or shall subsequently acquire a limited right to grant licenses for part or all of the field hereof, the licenses herein granted are subject to any limitations to which that right may be subject), and upon the terms and conditions hereinafter set forth, a personal, indivisible, non-transferable and non-exclusive license to RCA, its subsidiary and controlled companies and each of them, to manufacture, use and sell throughout the United States and its territories and possessions, including the right to export, apparatus for all uses, other than apparatus of the kinds and for the uses specified in Article II, Section 2 of said "Home" license executed by Hazeltine and RCA concurrently herewith; provided, that the license granted under this Section 1 shall extend to tubes sold to others by RCA, its subsidiary and controlled companies, for use in apparatus of the kinds specified in said Article II, Section 2, of said "Home" license but shall not extend to tubes actually licensed under said "Home" license agreement or under license granted by Hazeltine to others for the apparatus specified in said Article II, Section 2; and provided further, that

the license hereby granted for tubes for use in such apparatus specified in said Article II, Section 2, shall be extended only in respect of claims which cover merely the tubes themselves and shall not by implication, estoppel or otherwise extend to claims covering a combination of the tubes with other devices as, for example, in tube circuits and hook-ups.

The license to manufacture includes the right to make any or all of the separate parts and the right to have any or all of the separate parts made by others but no license is granted to sell parts except for legitimate repair of used apparatus or replacement of worn-out or defective parts of used apparatus."

4. That the meaning and intent of the parties expressed in the next to the last proviso, namely: "Provided, that the license granted under this Section 1 . . . shall not extend to tubes actually licensed . . . under license granted by Hazeltine to others for the apparatus specified in said Article II, Section 2" (inter alia, radio receivers) is that tubes sold by Radio Corporation of America and its affiliated companies to other licensees of Hazeltine are not licensed by Hazeltine; in other words, when a licensee of Hazeltine such as defendant purchases tubes from Radio Corporation of America, it is doing so pursuant to the express right of Article III, Section 1 permitting the licensee "to make all or any of the separate parts and the right to have all or any of the separate parts made by others," and in selling such tubes to the licensee Radio Corporation of America is not operating under its license and pays no royalties to Hazeltine thereon.

5. That the purposes of the foregoing exception to the grant of a general license to Radio Corporation of America covering tubes were to avoid the very situation urged by defendant herein, namely that having purchased tubes from Radio Corporation of America for inclusion in its receivers ("the apparatus specified in said Article II, Section 2") it could claim an implied license

from Hazeltine to use such tubes in an unlicensed manner and further to avoid the collection of a double royalty by Hazeltine on such tubes, one from Radio Corporation of America and a second from a licensed receiver manufacturer including such tubes in its receivers and paying a royalty on the basis of the complete receiver including tubes.

6. That of his own knowledge there are no provisions in either said "Home" or said "Commercial" licenses of Radio Corporation of America nor in any modifying letters thereof, nor is there any further agreement or understanding of any nature whatsoever between Hazeltine and Radio Corporation of America, granting that company any additional license with respect to tubes or in any way modifying the express provisions of the "Commercial" license quoted above.

LAURENCE B. DODDS.

Sworn to and subscribed before me this thirteenth day of February, 1948.

JOHN D. WOODBERRY,
Notary Public.

[SEAL].

At the same term, on February 13, 1948, the cause was set down for hearing before the Court, the Honorable Francis J. W. Ford, District Judge, sitting, on plaintiff's motion for summary judgment, and on defendant's countermotion for summary judgment, and after a full hearing, was taken under advisement.

The cause was then continued to the present March Term, 1948, when on April 28, 1948, the Court hands down its memorandum of decision granting plaintiff's motion for summary judgment and denying defendant's countermotion for summary judgment dismissing the action.

On June 21, 1948, the following Interlocutory Judgment is entered:

INTERLOCUTORY JUDGMENT.

[June 21, 1948.]

This cause having come on to be heard on the pleadings on plaintiff's motion for summary judgment under rule 56 of the Federal Rules of Civil Procedure and defendant's counter-motion for summary judgment and on the affidavits in support of and in opposition to both motions and attached documentary exhibits, and having been argued by counsel for both parties, and this Court having granted plaintiff's said motion and having denied defendant's said counter-motion by memorandum of decision dated April 28, 1948, thereupon, upon consideration thereof, it is ordered, adjudged and decreed as follows:

1. That the license agreement between the parties hereto dated as of September 1, 1942, a copy of which has been filed herein identified as Exhibit A, is good and valid at law and in full force and effect.

2. That plaintiff recover from defendant as minimum royalty under Section 4 of Article IV of said license agreement for the contract year from September 1, 1945 through August 31, 1946 the sum of Ten Thousand Dollars ($10,000) with interest at six per cent (6%) from its due date of September 30, 1946 and that execution may issue therefor.

3. That the plaintiff recover such further sums as are due to the plaintiff from the defendant at the date of this judgment under said license agreement, including royalties due with respect to all apparatus coming within the provisions of said license agreement, together with interest on such sums at six per cent (6%) from the respective dates upon which said sums were due for payment, and that this cause be referred to a Master to be appointed by this Court to take and state an account thereof and to report thereon with all convenient speed.

4. That a permanent injunction issue out of and under the seal of this Court directed to defendant, its officers and agents, enjoining and restraining them and each of them throughout the continuance in force of said license agreement from breaching

such provisions of Articles IV and V thereof as relate to defendant's obligation to plaintiff to pay royalties and to keep records and render statements from which the proper amounts of such royalty payments may be determined.

5. That defendant pay to plaintiff its costs to be taxed in this action.

FRANCIS J. W. FORD,
United States District Judge.

Boston, Massachusetts
June 21, 1948.

Approved as to form.

GEO. K. WOODWORTH,
Attorney for Defendant.
June 16, 1948.

RICHARD F. WALKER,
Attorney for Plaintiff.
6/16/48.

From the foregoing interlocutory judgment entered on June 21, 1948, the defendant, Automatic Radio Manufacturing Company, Inc., on the same day, files a notice of appeal to the United States Circuit Court of Appeals for the First Circuit.

On the same day, the defendant files the following Motion for Stay of Judgment, which motion, having been assented to by the plaintiff, is allowed on the same day by the Court, the Honorable Francis J. W. Ford, District Judge, sitting:

MOTION FOR STAY OF JUDGMENT.

[Filed June 21, 1948.]

Defendant moves the Court to stay the enforcement of the interlocutory judgment in this action, pending the disposition of defendant's appeal to the United States Circuit Court of Appeals for the First Circuit, and for that purpose to fix the amount of the bond required to be filed by defendant.

GEO. K. WOODWORTH,
Attorney for Defendant.

I do not object to the allowance of said Motion.

RICHARD F. WALKER,
Attorney for Plaintiff.

All'd. June 21-48.
F.J.W.F.
D. J.

On the same day, the following Order Granting Supersedeas is entered by the Court, the Honorable Francis J. W. Ford, District Judge, sitting:

ORDER GRANTING SUPERSEDEAS.
[June 21, 1948.]

This cause came on to be heard on motion of defendant for a stay of judgment, pending defendant's appeal to the United States Circuit Court of Appeals for the First Circuit, and it appearing to the Court that defendant is entitled to such a stay,

It is ordered that the execution of and any proceedings to enforce the interlocutory judgment, entered herein on the twenty-first day of June, be stayed, pending the determination of defendant's appeal from such interlocutory judgment, upon the filing by defendant and approval by this Court of a bond in the sum of eleven thousand dollars ($11,000) within 14 days from date hereof.

FRANCIS J. W. FORD,
United States District Judge.

Approved as to Form:

RICHARD F. WALKER,
Attorney for Plaintiff.

GEO. K. WOODWORTH,
Attorney for Defendant.

MEMORANDUM OF DECISION IN RE MOTIONS FOR SUMMARY JUDGMENT.

April 28, 1948.

FORD, D.J.

This is an action on a licensing contract under various patents which provides for the payment of royalties by defendant to plaintiff. Plaintiff, alleging nonpayment, seeks a judgment for the minimum annual royalty of $10,000; an accounting to determine any additional sum that may be due; an order that defendant comply with the terms of the contract in other respects, and such other relief as may be just.

Jurisdiction is based on diversity of citizenship, plaintiff being an Illinois corporation (assignee of a Delaware corporation) and defendant a Massachusetts corporation. The matter in controversy exceeds $3,000.

The plaintiff moves for summary judgment under Rule 56, F.R.C.P. Numerous affidavits have been filed by plaintiff in support of its motion. Defendant opposes the motion with affidavits, files a counter motion for summary judgment dismissing the action, and supports its motion with affidavits in opposition to which plaintiff has filed further affidavits.

A brief history of prior events will help to illuminate the conflicting claims. Hazeltine Corporation, a Delaware corporation, was organized in 1924 to exploit the invention of the neutrodyne radio circuit as embodied in three patents, and it did so with great success until the circuit became obsolete about 1929, because of the advent of the screen grid tube. In the meantime, through a program of research, it had developed many more patented inventions in the radio field, and by business arrangements acquired others. In 1946, Hazeltine Research, Inc., the plaintiff here, was organized in Illinois as a wholly owned subsidiary of Hazeltine Corporation, and took an assignment of all of the parent corporation's patents, patent applications and licensing contracts. The research program mentioned above is conducted by a third cor-

poration, the Hazeltine Electronics Corporation, also a wholly owned subsidiary of Hazeltine Corporation. All will be referred to as Hazeltine hereafter.

At present, Hazeltine owns or has the right to grant licenses under some 570 patents and 200 patent applications, largely in the field of radio and television. It is, with RCA, Westinghouse, Philco, etc., one of the largest licensors in the radio field. Its mode of operation is to license manufacturers of radio receivers under non-exclusive licenses entitling the manufacturer to the use of any or all of Hazeltine's patents. In return, the manufacturer agrees to pay therefor a fixed percentage of its gross sales of certain enumerated radio equipment. Defendant Automatic Radio Manufacturing Company is such a manufacturer of radio receivers and is licensed by Hazeltine. . . .

Defendant first took a license with plaintiff on October 1, 1935, but did not make payments thereunder. In December 1936, Hazeltine sued for royalties in the Massachusetts Superior Court, Suffolk County, which suit was settled and an interlocutory consent decree entered by which defendant admitted its use and the validity of numerous Hazeltine patents. A new license agreement was made for a period of five years from October 1, 1937, under which the parties operated for some two and one-half years, till February, 1940, when defendant failed to pay royalties. Upon plaintiff's application, the interlocutory consent decree became final on December 3, 1941, a new settlement was made, and a third license contract was drawn as of September 1, 1942, to run ten years from that date, this being the contract involved in the present litigation. Plaintiff waived any right to minimum royalties under the contract until August 30, 1945 because of the war time prohibition against production of civilian radio sets, but renewed its claim thereunder beginning September 1, 1945. Upon refusal of defendant to pay royalties or to make reports required by the contract, plaintiff filed this action on April 9, 1947.

Article III of the contract grants the licensee a "personal, in-

divisible, non-transferable and non-exclusive license" to manufacture and sell certain equipment such as radio receivers of sound and pictures, phonographs, and motion picture reproduction equipment, under a long list of plaintiff's patents; "the use in each case is limited to use in homes, use for educational purposes and private non-commecial use."

Article IV provides for royalties of 1.05% of the licensee's selling price on certain of the equipment specified in Article III and 2.1% on other such equipment. Section 4 provides for a minimum payment of $10,000 per year in the event royalties calculated as above do not exceed $10,000.

Article V requires the licensee to render monthly reports for the purpose of calculation of royalties, and designates the time and manner of payment.

Under Article VI, licensee agrees to mark all licensed apparatus with the statement: " 'Licensed by Hazeltine Corporation only for use in homes, for educational purpose, and for private, non-commercial use, under one or more of the following patents and under pending applications:' followed by the word 'Patent' and the numbers of the patents which are, in the opinion of Licensor, involved in apparatus of the types licensed hereunder . . .'"

In Article VIII, the licensor agrees to " . . . diligently prosecute such suits for infringement of the various patents under which licenses are herein granted as may in its judgment be reasonably necessary and prudent for enforcing those patents and preventing unlicensed competition . . .".

These are the provisions of the contract which are principally involved in this suit. There will be reference to other provisions in the course of the opinion.

This is an appropriate case for the application of summary procedure under Rule 56. There is no genuine issue as to any material fact, and both parties have moved for summary judgment. The contention of defendant that a genuine issue does arise with respect to certain questions of fact concerning plaintiff's motion

is without merit. I have reviewed the pleadings and affidavits and find no specific allegation of facts on personal knowledge required by Rule 56 (e). See *Engl* v. *Aetna Life Ins. Co.*, 139 F. (2d) 469, 473; *Peckham* v. *Ronrico Corp.*, 7 F.D.R. 324, 327; *cf. Griffin* v. *Griffin*, 327 U.S. 220, 236.

The contract was executed in New York; it provides by agreement of the parties that New York law shall govern; and at least part of its performance is due in New York. The Federal District Court sitting in Massachusetts in diversity cases will apply the Massachusetts rules of conflicts of law. *Klaxon Co.* v. *Stentor Electric Mfg. Co.*, 313 U.S. 487; *Sampson* v. *Channell*, 110 F. (2d) 754. Massachusetts courts determine the validity and interpretation of a contract in accordance with the law of the place where the contract was executed. *Adamowski* v. *The Curtiss-Wright Flying Service, Inc.*, 300 Mass. 281. In so far as it is necessary, I will, therefore, apply New York law. At the same time, it must be remembered that local rules of estoppel to contest the validity of a patent in a suit for royalties cannot override the strong public policy expressed in such federal enactments as the anti-trust laws. It follows that federal law will control the propriety of defenses based on the anti-trust laws. *Sola Electric Co.* v. *Jefferson Electric Co.*, 317 U.S. 173, 175; *Morton Salt Co.* v. *G.S. Suppiger Co.*, 314 U.S. 488, 492.

The contract involved here is essentially a grant by plaintiff of a privilege to defendant to use any patent or patent application which might be held by plaintiff in consideration for defendant's agreement to pay money. It is different from most license contracts in that payment of royalties does not depend on the use of plaintiff's patents by defendant, but is required regardless of any use by defendant. This is a convenient mode of operation designed by the parties to avoid the necessity of determining whether each type of defendant's product embodies any of the hundreds of patents which plaintiff controls. There is nothing inherently illegal in such an arrangement. *H-P-M Development*

Corp. v. *Watson-Stillman Co.*, 71 F. Supp. 906, 912. And non-use of the patents is not a defense to an action on the contract.

The contract requires defendant to pay 1.05% (and in one case 2.1%) of its gross sales of certain specified apparatus, with a minimum of $10,000 per year. Computation in this manner is designed to avoid the difficulties mentioned above. Defendant's contention that this method of computation is a misuse of plaintiff's patents has no merit. This is not an attempt by plaintiff to extend its monopoly to and collect royalties on unpatented articles (see *Motion Picture Patents Co.* v. *Universal Film Mfg. Co.*, 243 U.S. 502), but a convenient mode of computing the cost to defendant for the privilege of using the patents should defendant desire to make such use. Even where the license contract calls for royalties only when the patent is used, the amount of royalties can be measured by the total price of apparatus embodying unpatented as well as patented items. *H-P-M Development Corp.* v. *Watson-Stillman Co., supra; Pyrene Mfg. Co.* v. *Urquhart*, 69 F. Supp. 555; *American Optical Co.* v. *New Jersey Optical Co.*, 58 F. Supp. 601, 606; *International Carbonic Engineering Co.* v. *Natural Carbonic Products, Inc.*, 57 F. Supp. 248; *Ohio Citizens Trust Co.* v. *Air-way Electric Appliance Corp.*, 56 F. Supp. 1010, 1012.

Defendant urges, on the basis of *Pope* v. *Gormully*, 144 U.S. 224, that the contract cannot be enforced because defendant has admitted the validity of all of plaintiff's patents in the consent decree in the Massachusetts Court and that an agreement not to set up a defense to any suit is void as against public policy. The short answer to this is that the consent decree is not a part of this contract. The contract represents, on its face, a legitimate business bargain, and is in no way oppressive or unconscionable. The legal effect of the consent decree need not be passed upon in this suit. Furthermore, the defendant does not purport to contest the validity of all plaintiff's patents.

Defendant claims eviction from any right to use plaintiff's

patents and failure of consideration in that none are available for use. While eviction may be a good defense to an action for royalties under a license contract (*Drackett Chemical Co.* v. *Chamberlain Co.*, 63 F. (2d) 853; *Ross* v. *Fuller & Warren Co.*, 105 Fed. 510; *White* v. *Lee*, 14 Fed. 789; *Marston* v. *Swett*, 66 N.Y. 206), defendant has not made any serious effort to show eviction here and could not show it. Even though some of plaintiff's patents admittedly have been held invalid, there is no attempt to show that all or even a substantial number of them are unavailable for the use of defendant. It is quite clear that most of them have not been litigated and are presumptively valid. *Radio Corporation of America* v. *Radio Engineering Laboratories*, 293 U.S. 1, 7. Defendant thus gets, by the contract, what it bargained for, namely, the right to use whatever patents are available for use in plaintiff's large collection. It cannot complain that there is a failure of consideration if a particular patent has been invalidated even though it be the only patent he desired to use.

Defendant has made an extensive argument to the effect that the restriction on use which is imposed by the license notice required by Article VI of the contract is illegal in that it constitutes an attempt to extend the monopoly of the patent beyond its legitimate scope; that the imposition of such an illegal restriction is a misuse of the patent which vitiates the license agreement and renders it unenforceable; and it has cited numerous cases in the exegesis of this proposition. The license requires the following notice to be placed on articles manufactured under the license: "Licensed by Hazeltine Corporation only for use in homes, for educational purposes, and for private, non-commerical use, etc. . . ." If we suppose that defendant manufactured and sold a receiver under the license for an authorized use, and that it was purchased by one having notice of the restriction, and the purchaser acquired it for a purpose unauthorized by the license notice (e.g. for commercial use) and used it for such unauthorized pur-

pose, we have the case postulated by the defendant. It is the case expressly left open by the court in *General Talking Pictures Corp.* v. *Western Electric Co.*, 305 U.S. 124, 125: "Can a patent owner, merely by a 'license notice' attached to a device made under the patent, and sold in the ordinary channels of trade, place an enforceable restriction on the purchaser thereof as to the use to which the purchaser may put the device?" I do not deem it necessary to answer the question here. As between the licensor and licensee, the former can certainly restrict the licensee to manufacture and sales for limited use. *General Talking Pictures Corp.* v. *Western Electric Co., supra.* Even if the restriction imposed on a purchaser from the licensee should be invalid, there is no reason for permitting the licensee to escape its contract obligations thereby. If the restriction is invalid, then the article may go to the purchaser free of the restriction, but the contract between the licensor and licensee is not affected. The validity of the restriction should be tested in an action by the licensor against the licensee or the purchaser to enforce the restriction, not in an action on the contract by the licensor against the licensee. If there is any strong public policy against such restrictions, the policy can thus be fully protected by permitting the goods to go into commerce free of the restriction.

Defendant's most substantial defense is that set forth in paragraph 10 of its answer to the complaint: "That the plaintiff, in an illegal endeavor to eliminate all competition and secure an unlawful monopoly in violation of the antitrust laws of the United States, acquired the approximately 425 United States letters patent and the approximately 120 applications for United States letters patent . . . from its employees . . ." (and from other corporations and persons). If the issue of whether a monopoly existed was relevant to this case, I would not decide the question on summary procedure, but would require that it be submitted for trial. However, in this case, it is not necessary to decide the question. The license contract involved here is entirely separate from any

action of plaintiff to eliminate competition or engage in a monopoly. Assuming; arguendo, it was engaged in an unlawful scheme to maintain a monopoly, the contract here was not an integral part of it. The contract in suit did not help to promote any monopoly plaintiff had established. See *American Refining Co.* v. *Gasoline Products Co.*, 294 S.W. 967. The contract here is complete in itself and enforceable without reference to any contract of the plaintiff with others or of any illegal activity on the part of plaintiff in violation of the anti-trust laws. It being itself a valid contract, collateral activities of the plaintiff do not render it unenforceable. *Gasoline Products Co. Inc.* v. *Champlin Refining Co.*, 46 F. (2d) 511, 514; Walker on Patents, Vol. II, Sec. 409, p. 1590, and cases; *cf. Radio Corporation of America* v. *Majestic Distributors*, 53 F. (2d) 641. (Compare *United Shoe Machinery Co.* v. *La Chapelle*, 212 Mass. 467, where the contract in issue was held to be an essential means of maintaining the illegal monopoly of plaintiff.) The defense that plaintiff is using its patents to force others, not the defendant, to assign to plaintiff rights under their patents is rejected on the same ground.

The defenses of fraud and waiver of minimum royalties are rejected as having no basis on the facts set forth. The defense of breach of contract by plaintiff because of failure diligently to prosecute infringers is rejected on the facts reflected in the affidavits. Article VIII only requires plaintiff to prosecute infringers as "may *in its judgment* be reasonably necessary and prudent . . ." (Emphasis mine.) This relieves the court of substituting its judgment for that of the plaintiff. However, the facts indicate that plaintiff has acted diligently in this respect. The remainder of defendant's numerous defenses are rejected as not justified on the undisputed facts.

Plaintiff's motion for summary judgment is granted and it will submit a form of judgment for approval by the court.

Defendant's counter motion for summary judgment dismissing the action is denied.

NOTICE OF APPEAL TO CIRCUIT COURT OF APPEALS.

[Filed June 21, 1948.]

Notice is hereby given that Automatic Radio Manufacturing Company, Inc., defendant above named, hereby appeals to the United States Circuit Court of Appeals for the First Circuit from the interlocutory judgment entered in this action on June 21, 1948.

GEO. K. WOODWORTH,
Attorney for Defendant-Appellant.
19 Congress St., Boston, Mass.

On June 29, 1948, the defendant files a bond on appeal in the sum of eleven thousand dollars, the Maryland Casualty Company acting as surety, which bond, on June 30, 1948, is approved by the Court, the Honorable Francis J. W. Ford, District Judge, as a supersedeas.

STATEMENT OF POINTS UPON WHICH DEFENDANT WILL RELY ON ITS APPEAL.

[Filed June 29, 1948.]

1. The District Court erred in holding that the contract between the parties herein is good and valid at law and in full force and effect and in not holding that said contract is invalid in law, for the reason that said contract requires the payment of royalties under a pool of patents even although the licensee makes no use of the licensed patents, or any of them.

2. The District Court erred in not holding that the licensee contract between the parties herein, requiring defendant to pay a certain percentage of its net selling price on all of its apparatus under a pool of patents, even though no patent is used in said apparatus, is a misuse of plaintiff's patents and is an attempt by plaintiff to extend its monopoly to collect royalties on unpatented articles.

3. The District Court erred in not holding that the decision in *Pope* v. *Gormully*, 144 U.S. 224, is authority that a licensee under 570 patents and 200 patent applications may challenge validity in a suit for royalties, and in not holding that unless such validity may be challenged, the license agreement must be interpreted to conflict with that decision.

4. The District Court erred in finding that defendant does not contest the validity of all plaintiff's patents.

5. The District Court erred in not ruling that a consent decree in the Massachusetts Superior Court, entered December 3, 1941, wherein defendant admitted the validity of all of plaintiff's patents, is void as against public policy, and that, for this reason, plaintiff's motion for summary judgment should be denied.

6. The District Court erred in not holding that the restrictive reuse patent marking notice required by the licensee agreement is illegal, for the reason that it was an attempted restriction on the use of radios after they had been purchased from the defendant, as distinguished from a use of such radios by the defendant.

7. The District Court erred in holding that it is practicable to stop illegal license notice restrictions through suits brought by the licensor against members of the general public and in ruling that the fact that the goods actually go into commerce free of restriction removes the illegality of the attempted restriction.

8. The District Court erred in deciding that the license agreement involved herein is entirely separate from any action of plaintiff to elminate competition or engage in a monopoly, and in not holding that said agreement is an essential and integral part of plaintiff's illegal monopoly or restraint of commerce.

9. The District Court erred in holding that defendant did not show eviction from its license to use plaintiff's patents and release from any obligation to pay royalties on account of failure of consideration due to the invalidation by the Federal Courts of all of the licensed patents that have been adjudicated by the plaintiff, Hazeltine Research, Inc., or its predecessor, Hazeltine

Corporation, particularly where no unadjudicated patents are used by defendant.

10. The District Court erred in failing to hold that defendant had the right to repudiate its license contract under New York law.

11. The District Court erred in failing to hold that defendant had repudiated its license contract on September 18, 1947 and was free of any obligation to pay royalties thereafter.

12. The District Court erred in failing to find and rule that an owner of a patent by means thereof cannot restrict the use made of a device manufactured under the patent, after the device has passed into the hands of a purchaser in the ordinary channels of trade, and full consideration paid therefor.

13. The District Court erred in failing to find and rule that a patent owner cannot merely by a license notice attached to a device made under the patent and sold in the ordinary channels of trade, place an enforceable restriction on the purchaser thereof as to the use to which the purchaser may put the device.

14. Plaintiff's patents have been so misused by plaintiff and its predecessor, as to deprive plaintiff of the aid of a court of equity to enforce its license agreement between the parties herein, such misuse including:

(a) Requiring its licensees to apply patent marking notices to radio sets made by them, which notices include restrictions as to the permitted use of the sets by the purchasers thereof;

(b) Requiring its licensees to mark on radio sets made by them patents which are not used in said sets and which are invalid;

(c) Entering a coercive "consent" decree on December 3, 1941, in the case of *Hazeltine Corporation* v. *Automatic Radio Manufacturing Company, Inc.*, Superior Court, Suffolk County, Massachusetts, Equity No. 47,229, which decree is void as being contrary to public policy;

(d) Requiring its licensees to sign license agreements which are

so oppressive in their terms as to be contrary to public policy and void;

(e) Requiring its licensees to pay royalties on all radio sets sold by them, whether or not said sets employ the inventions of any of plaintiff's patents and whether or not said patents are invalid;

(f) Improperly using its patents to compel others to assign to plaintiff, or its predecessor, rights under patents owned by them;

(g) Refusing to grant a license under any one or more of its patents to anyone who refuses to take a license under all;

(h) Suing and threatening to sue and otherwise harassing radio manufacturers refusing to take licenses under its patents and their customers with suits and threats of repeated expensive infringement suits and coercing radio manufacturers to take such licenses by suits and threats of suits;

(i) Forcing its licensees to pay royalties on radio tubes purchased by them from the Radio Corporation of America, which company has a license from plaintiff to make and sell said tubes under plaintiff's patents and which tubes were, therefore, freed from said patents at the time of their purchase, thereby enforcing the payment of royalties on unpatented tubes;

(j) Amassing a vast number of radio patents not for use, but for the purpose of coercing the payment of royalties on all radio sets;

and the District Court erred in not so finding and ruling.

15. The license agreement between the parties is invalid and void at law and without legal force or effect, for the following reasons:

(a) Said agreement is so oppressive and unconscionable in its terms as to be void as against public policy;

(b) Said agreement was breached in its inception and has been continuously breached since, by the failure of plaintiff and

its predecessor to prosecute alleged infringers of its patents diligently;

(c) For failure of consideration, plaintiff and its predecessor having no valid patents covered by said license, and for eviction from said license due to the decisions of the courts holding the best of said patents invalid and not infringed during the term of the license;

(d) Because plaintiff's patents have been misused and are unenforceable;

(e) Said agreement requires the payment of patent royalties on devices and parts thereof not covered by plaintiff's patents, and on parts already licensed and thereby freed from plaintiff's patents;

and the District Court erred in not so finding and ruling.

16. The District Court erred in finding and ruling that defendant cannot complain of failure of consideration in a license under pooled patents "if a particular patent has been invalidated, even though it be the only patent he (sic) desired to use," for the reason that such finding and ruling is equivalent to saying that defendant is liable for royalties on an invalid patent, i.e., to use and did use the structure defined by the claims of the invalidated patent.

17. The District Court erred in finding that allegations of facts made on information and belief do not fulfill the requirements of Rule 56 (e) when those facts are within the direct knowledge of the opposing party, (in this case, Hazeltine), are not within the direct knowledge of the moving party, (in this case, Automatic) and are not denied by said opposing party; and in not giving weight to such allegations.

18. The District Court erred in decreeing that plaintiff recover from defendant as minimum royalty under Section 4 of Article IV, from September 1, 1945 through August 31, 1946, the sum of ten thousand dollars ($10,000) with interest at 6% from September 30, 1946.

19. The District Court erred in decreeing that plaintiff recover from defendant as royalty, further sums from September 1, 1946, to the date of this judgment and in referring the case to a master to take and state an account thereof.

20. The District Court erred in decreeing an injunction enjoining and restraining defendant and its officers and agents from breaching the provisions of articles IV and V of the license agreement between the parties and to keep records and render statements to plaintiff.

21. The District Court erred in decreeing that defendant pay to plaintiff its taxable costs.

22. The District Court erred in granting plaintiff's motion for summary judgment.

23. The District Court erred in not granting defendant's countermotion for summary judgment.

FLOYD H. CREWS,
GEORGE K. WOODWORTH,
Attorneys for Defendant.

Service accepted this twenty-ninth day of June, 1948.

CLARENCE H. PORTER,
Attorney for Plaintiff.

DEFENDANT'S DESIGNATION OF CONTENTS OF RECORD ON APPEAL.

[Filed June 29, 1948.]

1. Complaint and Exhibit A annexed, filed April 9, 1947.

2. Answer, filed April 26, 1947, as amended by motion filed September 30, 1947, approved by the Court October 30, 1947.

3. Defendant's motion to amend its answer and the affidavit of David Housman annexed, filed September 30, 1947.

4. Stipulation re certain of defendant's models, filed October 28, 1947.

5. Stipulation re defendant's motion to amend its answer, filed October 30, 1947.

6. Plaintiff's motion for summary judgment and the affidavits annexed thereto, filed November 10, 1947, as follows:

John K. Gowen, Jr.,
John R. Binns, including Exhs. O through R2,
Harold A. Wheeler, including Exhs. S through Z and AA and BB.

7. Defendant's countermotion for summary judgment and affidavit of George K. Woodworth annexed, filed February 2, 1948.

8. Defendant's affidavits in opposition to plaintiff's motion for summary judgment, as follows:

David Housman,
George K. Woodworth and Leo A. Kelley, including the exhibits annexed to said affidavit of Leo A. Kelley, filed February 11, 1948.

9. Plaintiff's affidavits in opposition to defendant's countermotion for summary judgment, as follows:

John R. Binns, including Exhs. CC, DD, and EE, annexed,
Laurence B. Dodds, and
Richard F. Walker, including annexed exhibit, filed February 12, 1948.

10. Defendant's affidavit in rebuttal to affidavit of John R. Binns, filed February 11, 1948, as follows:

Affidavit of Charles R. Wexler, filed February 12, 1948, including Exhs. A, B and C, annexed thereto.

11. Defendant's affidavits in reply to affidavit of John R. Binns, filed February 11, 1948, as follows:

Floyd H. Crews, verified February 11, 1948, and
Floyd H. Crews, Verified February 12, 1948, filed February 13, 1948.

12. Plaintiff's affidavit, as follows:

Laurence B. Dodds, filed February 13, 1948.

13. Court's memorandum of decision, filed April 28, 1948.

14. Interlocutory judgment, entered June 21, 1948.

15. Defendant's notice of appeal, filed June 21, 1948.

16. Defendant's motion for stay of judgment, filed June 21, 1948.

17. Court's order on supersedeas, filed June 21, 1948.

18. Supersedeas bond, filed.

19. Statement of points relied upon on appeal, filed simultaneously herewith.

20. This designation.

The Clerk is requested to transmit as physical exhibits:

(1) Defendant's interrogatories to plaintiff, filed April 28, 1947,

(2) Plaintiff's answers to defendant's interrogatories, and Exhs. B through N annexed, filed May 27, 1948.

FLOYD H. CREWS,
GEORGE K. WOODWORTH,
Attorneys for Defendant, AUTOMATIC RADIO MANUFACTURING COMPANY, INC.

Service accepted this twenty-ninth day of June, 1948.

CLARENCE H. PORTER,
Attorney for Plaintiff, HAZELTINE RESEARCH, INC.

PLAINTIFF'S DESIGNATION OF ADDITIONAL PORTIONS TO BE CONTAINED IN THE RECORD ON APPEAL.

[Filed July 6, 1948.]

Plaintiff-Appellee, Hazeltine Research, Inc., files its designation of additional portions of the record, proceedings and evidence to be contained in the record on appeal, as follows:

21. Defendant's interrogatories to plaintiff, filed on or about April 28, 1947.

22. Plaintiff's answers to interrogatories propounded by de-

fendant and annexed exhibits marked Exhibits B through N inclusive, filed on or about May 27, 1947.

23. This designation.

ROBERTS, CUSHMAN & GROVER,
CLARENCE H. PORTER,
Attorneys for Plaintiff.

Service acknowledged this second day of July, 1948.

GEO. K. WOODWORTH,
Attorney for Defendant.

CLERK'S CERTIFICATE.

I, John A. Canavan, Clerk of the District Court of the United States for the District of Massachusetts, do hereby certi y that the foregoing is the record on appeal, as designated by the parties, in the cause entitled,

NO. 6677, CIVIL ACTION,

HAZELTINE RESEARCH, INC.,
Plaintiff,

v.

AUTOMATIC RADIO MANUFACTURING COMPANY, INC.,
Defendant,

in said District Court determined.

In testimony whereof, I hereunto set my hand and affix the seal of said Court, at Boston, in said District, this nineteenth day of August, 1948.

[SEAL] JOHN A. CANAVAN, *Clerk.*

[MEMORANDUM: An order of enlargement of time for docketing case to, and including August 30, 1948, is here omitted. JOHN A. CANAVAN, *Clerk.*]

[fols. 313-314] PROCEEDINGS IN COURT OF APPEALS

On December 8, 1948, this cause came on to be heard, and was fully heard by the Court, Honorable Calvert Magruder, Chief Judge, Honorable Peter Woodbury, Circuit Judge, and Honorable George C. Sweeney, District Judge, sitting.

On August 22, 1949, the following opinion of the Court and dissenting opinion were filed:

[fol. 315] UNITED STATES COURT OF APPEALS FOR THE FIRST CIRCUIT, OCTOBER TERM, 1948

No. 4381

AUTOMATIC RADIO MANUFACTURING COMPANY, INC., Defendant, Appellant,

v.

HAZELTINE RESEARCH, INC., Plaintiff, Appellee

APPEAL FROM THE UNITED STATES DISTRICT COURT FOR THE DISTRICT OF MASSACHUSETTS

[77 F. Supp. 493]

Before Magruder, Chief Judge, Woodbury, Circuit Judge, and Sweeney, District Judge.

Floyd H. Crews, with whom George K. Woodworth and Darby & Darby were on brief, for appellant.

Laurence B. Dodds, with whom Richard F. Walker and Roberts, Cushman & Grover were on brief, for appellee.

OPINION OF THE COURT—August 22, 1949

MAGRUDER, *Chief Judge:*

This is a suit for royalties alleged to be due under a patent license agreement between the defendant, Automatic Radio Manufacturing Company, Inc., a Massachusetts corporation (hereinafter called Automatic), and the plaintiff's assignor, Hazeltine Corporation, a Delaware corporation. Plaintiff Hazeltine Research, Inc., is an Illinois corporation organized as a wholly owned subsidiary [fol. 316] of Hazeltine Corporation. Hazeltine Electronics Corporation, another wholly owned subsidiary of Hazeltine

Corporation, conducts the research program about to be mentioned. We shall refer to these corporations collectively as Hazeltine.

For many years Hazeltine has engaged in a program of radio research, as a result of which it has developed many patented inventions. Other patents have been acquired by it through various business arrangements. At the time of this suit, Hazeltine owned, or had the right to grant licenses under, five hundred and more patents and approximately two hundred patent applications, chiefly pertaining to radio and television. As one of the largest licensors in the radio field, it has granted non-exclusive licenses to radio manufacturers, permitting them to use any or all of Hazeltine's patents, in return for a royalty payment of a fixed percentage of gross sales of various types of radio equipment.

Automatic first became a licensee of Hazeltine in 1935. It defaulted on its royalty obligations under the first two agreements with Hazeltine. However, in each instance a settlement was reached, and the relationship continued. The present contract between the parties became effective September 1, 1942, to run ten years, subject to an option of earlier termination by the licensor upon the happening of certain specified events. Automatic was given a non-transferable, non-exclusive license, under a schedule of enumerated patents and all other patents with respect to which Hazeltine should acquire the right to grant licenses during the period of the agreement. The license authorized Automatic to utilize such patents in the manufacture and sale of certain described radio, phonographic, and other equipment, "limited to use in homes, use for educational purposes and private non-commercial use." Automatic agreed to pay royalties expressed in terms of a specified percentage of [fol. 317] the selling price of each piece of the enumerated types of equipment manufactured and sold by the licensee, whether or not any of such patents were actually used in the manufacture of the particular apparatus. In any case, the agreement called for a minimum royalty payment of $10,000 per year.

The contract, in Article VI, further provided—and appellant makes much of this—that the licensee

> "agrees to mark all licensed apparatus manufactured and sold by Licensee hereunder, in readily legible form, with the statement 'Licensed by Hazeltine Corporation

only for use in homes, for educational purposes, and for private, non-commercial use, under one or more of the following patents and under pending applications:' followed by the word 'Patent' and the numbers of the patents which are, in the opinion of Licensor, involved in apparatus of the types licensed hereunder manufactured by one or more licensees of Licensor. The marking required by this section shall be affixed to said licensed apparatus by attaching plates bearing the required marking or by affixing said marking on said apparatus in some other form equally permanent and apparatus not bearing such marking is not licensed."

It was found by the district court that the contract was executed in New York, and that at least part of the performance thereunder was due in New York. The concluding article of the contract provided that it was to be "governed by and interpreted in accordance with the laws of the State of New York."

Because of wartime restrictions on the production of radio sets for private use, Hazeltine waived demand for payment of the minimum annual royalties from September, 1942, through August 30, 1945. Upon refusal of Automatic to pay royalties thereafter, Hazeltine filed its complaint in [fol. 318] the present case on April 9, 1947. Plaintiff prayed for a judgment that Automatic pay to Hazeltine the minimum sum due under the contract for the year ending August 31, 1946, with interest; that an accounting be had and that the further sums due be determined and decreed to be paid to the plaintiff with interest; "that defendant render to the plaintiff the statements required by said agreement throughout the continuance in force of said agreement"; that defendant pay plaintiff's costs herein; and that plaintiff have such other and further relief as may be just.

After Automatic's answer was filed, both parties filed motions for summary judgment and submitted supporting affidavits. A hearing was held on the motions, and the district court concluded that the case was one appropriate for the application of summary judgment procedure since there was "no genuine issue as to any material fact." Hazeltine's motion was granted and Automatic's motion denied. 77 F. Supp. 493.

On June 21, 1948, an "Interlocutory Judgment" was entered, in which it was adjudged and decreed as follows:

(1) That the license agreement between the parties dated as of September 1, 1942 "is good and valid at law and in full force and effect."

(2) That plaintiff recover from defendant as minimum royalty under the license agreement, for the year ending August 31, 1946 the sum of $10,000 with interest, "and that execution may issue therefor."

(3) That plaintiff recover such further sums as are due from the defendant at the date of this judgment under said license agreement, and that the case be referred to a Master to take and state an account thereof.

(4) That "a permanent injunction issue out of and under the seal of this Court directed to defendant, its [fol. 319] officers and agents, enjoining and restraining them and each of them throughout the continuance in force of said license agreement from breaching such provisions of Articles IV and V thereof as relate to defendant's obligation to plaintiff to pay royalties and to keep records and render statements from which the proper amounts of such royalty payments may be determined."

This court has jurisdiction to entertain the present appeal from such judgment, pursuant to provisions of the Judicial Code now found in 28 U. S. Code §§ 1291, 1292(1), and 1294(1) (1948). Counsel for both parties approved the judgment "as to form," and no question is presented here as to the scope of the injunction.

Automatic raised, and the district court considered, numerous defenses. In examining the judgment of the district court, we confine our attention only to those matters presented in this appeal. In its brief, Automatic has enveloped the case in an atmosphere of overreaching and chicanery hardly warranted on the record. A lengthy affidavit executed by one of counsel for Automatic, and filed by Automatic in support of its motion for summary judgment, contains many sweeping claims and charges, but the affidavit was made for the most part "on information and

belief," and not on personal knowledge, as required by Rule 56(e).

I. Patent Misuse

Appellant has advanced a variety of defenses to sustain the proposition that Hazeltine has so misused the monopoly of its patent grants as to have disentitled itself to any relief under the present complaint.

Restrictive Use Notices.—Automatic argues that the requirement in the license agreement that licensed apparatus be marked with a "restrictive use" notice, as above stated, [fol. 320] constitutes such a misuse of the patent as to render the agreement unenforceable. This contention must be rejected on the authority of *General Talking Pictures Corp.* v. *Western Elec. Co.*, 304 U. S. 175 (1938), and upon rehearing, 305 U. S. 124 (1938). In that case a non-exclusive license "was expressly confined to the right to manufacture and sell the patented amplifiers for radio amateur reception, radio experimental reception, and home broadcast reception." 304 U. S. at 180. The agreement required the licensee to affix to all amplifiers sold under the license a notice stating that the apparatus was licensed only for the aforesaid uses. Amplifiers with such notices attached were sold by the licensee to a purchaser who intended to and did put them to use in theaters as part of talking picture equipment. At the time of order, manufacture and sale, both the licensee and the purchaser knew of the purchaser's intended commercial use, and the purchaser knew that the license did not authorize the licensee to make and sell amplifiers for that use. Speaking through Mr. Justice Brandeis, the Supreme Court on rehearing reaffirmed its earlier view that the purchaser was accountable as an infringer. "That a restrictive license is legal seems clear. . . . The practice of granting licenses for a restricted use is an old one, see *Rubber Company* v. *Goodyear*, 9 Wall. 788, 799, 800; *Gamewell Fire-Alarm Telegraph Co.* v. *Brooklyn*, 14 Fed. 255. So far as appears, its legality has never been questioned. . . . As the restriction was legal and the amplifiers were made and sold outside the scope of the license the effect is precisely the same as if no license whatsoever had been granted to [the licensee]. And as [the purchaser] knew the facts, it is in no better position than

if it had manufactured the amplifiers itself without a license. It is liable because it has used the invention without license to do so." 305 U. S. at 127. Consequently, the [fol. 321] Court continued, there was "no occasion to consider what the rights of the parties would have been if the amplifier had been manufactured 'under the patent' and 'had passed into the hands of a purchaser in the ordinary channels of trade.' Nor have we occasion to consider the effect of a 'licensee's notice' which purports to restrict the use of articles lawfully sold."

We must conclude from the decision in the *General Talking Pictures* case that a license agreement is not necessarily invalid because the licensee is granted a restricted right to make and vend a patented apparatus for use limited to a particular, described field, and is required by the agreement to affix to the licensed apparatus a notice of such restricted use. There may be circumstances under which a notice of restricted use would be inoperative and unenforceable as-against subsequent purchasers, but that problem is not presented in the case at bar. And it is to be noted that the judgment from which this appeal is taken does not even command Automatic, the licensee, to comply with the term of the agreement requiring it to attach the restrictive use notices to the licensed apparatus sold by it.

General Talking Pictures Corp. v. *Western Elec. Co.* has not been overruled by the Supreme Court. Appellant contends that the case was wrongly decided, and that the authority of the case has been more or less undermined by subsequent decisions of the Supreme Court on related subject matters. From our examination of the later cases we are not satisfied that this is so; at any rate, we decline to speculate on whether the case would now be followed by the Supreme Court. If the case is to be overruled, that must be done by the Supreme Court. Meanwhile, it is our duty to follow it.

In fact, it appears that none of the radio apparatus made and sold by Automatic has been marked with the restrictive use notice required by Article VI; in other words, Auto- [fol. 322] matic has consistently ignored this provision of the agreement. Automatic makes the curious suggestion that its own breach of this term of the contract affords an independent ground for relieving it of the obligation to pay the stipulated percentage royalties. The argument is based

upon the provision of Article VI that apparatus not bearing the restrictive use notice "is not licensed"; and therefore, Automatic argues, since "no licensed apparatus for which royalties are due under the contract has ever been made or sold," the district court erred in requiring an accounting of percentage royalties. Under the foregoing circumstances, no doubt Hazeltine would have had an election to proceed against Automatic on the theory of infringement. But the above contract provisions are for the benefit of the licensor, who may choose to waive them. Notwithstanding the failure of Automatic to attach the restrictive use notices, Hazeltine is entitled to insist upon the performance by Automatic of its contract obligation under Article IV to pay as royalties a percentage of the selling price of each complete apparatus of the types listed in Article III, Section 2, "sold by Licensee during continuance of this license."

Royalty Payments.—It has been pointed out above that the license agreement gave Automatic the right to make use of any of Hazeltine's patents, and required Automatic to pay royalties measured by a percentage of the selling price of all radio apparatus of specified types manufactured and sold by Automatic, whether or not any particular apparatus in fact utilized any of the inventions of the Hazeltine patents, with a minimum royalty payment of $10,000 a year. There is no valid objection to this sort of agreement; the parties are free to bargain as to the basis upon which the royalties are to be computed. *H-P-M Development Corp.* v. *Watson-Stillman Co.*, 71 F. Supp. 906 (D. N. J. [fol. 323] 1947); *Cf. Ingene Mfg. Co.* v. *Urquhart*, 69 F. Supp. 555, 560 (E. D. Pa. 1946); *American Optical Co.* v. *New Jersey Optical Co.*, 58 F. Supp. 601, 606 (D. Mass. 1944); *Ohio Citizens Trust Co.* v. *Air-Way Elec. Appliance Corp.*, 56 F. Supp. 1010, 1012 (N. D. Ohio 1944). As stated in one of Hazeltine's affidavits, this type of royalty clause was originally adopted "for convenience of accounting." The Court below stated: "This is a convenient mode of operation designed by the parties to avoid the necessity of determining whether each type of defendant's product embodies any of the hundreds of patents which plaintiff controls." 77 F. Supp. at 496. Certainly a licensee, in consideration of the grant of the right to use a licensor's patent, may lawfully promise to pay the licensor a fixed sum

per year during the life of the agreement; and this promise would not become unenforceable merely because the licensee in a particular year happened not to utilize the invention. If this is so, it would be no more against public policy to stipulate for a variable consideration by way of royalty for the right to use the patent, whether such consideration were expressed in terms of a percentage of the net profits of the licensee's business, or (as here) in terms of a percentage of the selling price of certain apparatus manufactured and sold by the licensee. Depending on the circumstances such a percentage royalty might well be a lesser charge upon the licensee's business than a stipulation for payment of a flat sum yearly.

A different problem would be presented if the license agreement had provided that, in part consideration for the right to make use of Hazeltine's patents, Automatic agreed not to compete in the commercial field in the manufacture and sale of any radio apparatus of the types enumerated, even though such apparatus did not embody any of the inventions covered by Hazeltine's patents. Such an agree- [fol. 324] ment might be unenforceable as constituting an unlawful attempt to extend the monopoly of licensor's patents beyond the limits of the patent grants. But as we read the license agreement in the case at bar, Automatic would not break the agreement by manufacturing and selling for unrestricted use radio apparatus which in fact does not embody any of the inventions covered by Hazeltine's patents. This is true notwithstanding the fact that Automatic, in making such a sale, would be required by Article IV, Section 1, of the agreement to pay to Hazeltine the stipulated percentage of the selling price as royalty for the *right* to utilize the patents covered by the license agreement.

Duress.—Automatic's brief states that its affidavits "assert the license was signed only in fear of disastrous litigation. If it was, in fact, coerced into taking a license under invalid patents having no application to any radio set made today, the patents were obviously misused." Not all economic pressure constitutes "duress" rendering a contract voidable. The defense of duress is discussed in 5 Williston, Contracts § 1606 (Rev. ed. 1937), where it is pointed out that the pressure exerted must be wrongful; that a threat

to resort to civil litigation is not such duress as to justify rescission of a transaction induced thereby, even though there is no legal right to enforce the claim, provided the threat is made in good faith, that is, in the belief that a possible cause of action exists. Neither Automatic's answer nor its amended answer set up duress as a defense. Notwithstanding the statement in Automatic's brief, the record in fact contains no specific allegation that Automatic was improperly coerced into executing the license agreement now in suit. There is a statement in Automatic's counter motion for summary judgment, as one of the asserted grounds for dismissal of the complaint, that Hazeltine has misused its patents by suing and threatening to sue, and [fol. 325] otherwise harassing customers of radio manufacturers refusing to take a license under its patents "and coercing radio manufacturers to take licenses under its patents by threats of repeated, expensive law suits"; and a similar statement is made in one of the supporting affidavits.[1] Even if—as would hardly be justified—we take this allegation to imply that Hazeltine improperly coerced other radio manufacturers to enter into license agreements by threats of patent infringement suits which Hazeltine knew to be unfounded, such wrongful conduct in respect to third persons would constitute no defense to Automatic in the present suit. A promisee's cause of action on one contract cannot be defeated merely by a showing that the promisee had improperly coerced third parties into entering into similar contracts with him. See 6 Williston, Contracts § 1752 (Rev. ed. 1938); 2 Restatement, Contracts § 597 (1932). This generally accepted rule of law should not, in our view, be discarded by an extension of the decision in *Morton Salt Co.* v. *G. S. Suppiger Co.*, 314 U. S. 488 (1942), which dealt with quite a different set of facts not involving the assertion of third-party defenses by a defendant sued for breach of contract.

Monopoly.—Automatic has claimed that Hazeltine's alleged monopolistic practices should preclude its recovery

[1] It appears that among the other licensees of Hazeltine are General Electric Corporation, Westinghouse Electric Corporation, and Radio Corporation of America. R.C.A. paid approximately one million dollars in royalties to Hazeltine during the years 1937-1947.

here: Its answer alleged as a defense that Hazeltine "in an illegal endeavor to eliminate all competition and secure an unlawful monopoly in violation of the antitrust laws of the United States, acquired the approximately 425 United States letters patent and the approximately 120 applications for United States letters patent . . . from its employees" (and from other corporations and persons). From Auto- [fol. 326] matic's somewhat nebulous generalizations, it is difficult to ascertain the precise nature of its argument on this score, though it does concede that the mere accumulation of patents, however great in number, is not illegal *per se*. *Cf. Transparent-Wrap Machine Corp.* v. *Stokes & Smith Co.*, 329 U. S. 637 (1947). As one of the grounds in support of its counter motion for summary judgment, Automatic asserted that Hazeltine has misused its patents by "refusing to grant a license under any one or more of its patents to anyone who refuses to take a license under all." The only factual support we have been able to find for this allegation is a statement in one of Automatic's affidavits, made by the affiant on information and belief, not as a matter of personal knowledge. It is indeed nowhere alleged that Automatic had sought and been refused a license covering less than all of Hazeltine's patents. This particular contention has not been pressed on appeal as a separate ground of defense.

In most other respects, it appears that the defense of monopolistic practices is merely the assembling under a different heading of matters we have already considered. The district court correctly ruled that, even assuming *arguendo* that Hazeltine was engaged in an unlawful scheme to maintain a monopoly, the license contract in suit was not an integral part of it; that the license agreement, being itself a valid contract, will not be rendered unenforceable by collateral activities of the plaintiff in violation of the anti-trust laws. 2 Restatement, Contracts § 519 (1932); 5 Williston, Contracts § 1661 (Rev. ed. 1937); 2 Walker, Patents § 409 (Deller ed. 1937). See also *Bruce's Juices, Inc.* v. *American Can Co.*, 330 U. S. 743, 754, 755-56 (1947). *Morton Salt Co.* v. *G. S. Suppiger Co.*, 314 U. S. 488 (1942), is no authority for the proposition that a contract action for patent royalties may be bogged down by the defendant into [fol. 327] a complicated and protracted trial of asserted collateral infractions of the anti-trust laws. And see *Radio*

Corporation of America v. *Majestic Distributors*, 53 F. 2d 641, 642-43 (D. C. Conn. 1931), and cases cited.

H. Alleged Invalidity of Hazeltine's Patents

Until recently, it had generally been thought to be settled law that, in a suit for patent royalties under a license agreement, the licensee was estopped from challenging the validity of the licensor's patent. *United States* v. *Harvey Steel Co.*, 196 U. S. 310 (1905); 2 Walker, Patents § 383 (Deller ed. 1937). *Edward Katzinger Co.* v. *Chicago Metallic Mfg. Co.*, 329 U. S. 394 (1947), and *MacGregor* v. *Westinghouse Elec. & Mfg. Co.*, 329 U. S. 402 (1947), established that this proposition can no longer be received without qualification. In each of those cases the licensee had agreed to sell the licensed products at prices fixed by the licensor. "Such a restriction on the price of articles entering interstate commerce is a violation of the Sherman Act save only as it is within the protection of a lawfully granted patent monopoly." *Sola Elec. Co.* v. *Jefferson Elec. Co.*, 317 U. S. 173, 175 (1942). The Court, in the *Katzinger* and *MacGregor* cases, deemed the price-fixing undertaking to be an inseparable part of the "integrated consideration for the license grant"; and in these circumstances concluded that the public interest in "freedom from invalid patents and from restraints of trade" (329 U. S. at 401) would best be served by allowing the licensee to set up the invalidity of the patent in defense to a suit for royalties. It confined its decision to the set of facts before it, and pointedly declined to lay down the broader rule that a licensee may in all cases defend on the ground of invalidity of the patent even when no price-fixing stipulation was involved in the license contract. [fol. 328] 329 U. S. at 399. As to that, the Court reserved judgment.

Until we receive further light and leading from the Supreme Court, we are disinclined to extend the holdings in the *Katzinger* and *MacGregor* cases so as to throw into the discard altogether the long line of earlier cases disallowing a licensee to challenge the validity of the licensor's patent. It is not uncommon for the parties to a patent infringement suit, in which there is a genuine issue as to the validity of the patent, to make a settlement of the litigation by an agreement under which the patentee gives a license to the alleged infringer in consideration of the payment of a stipu-

lated royalty. Indeed, the license agreement in suit seems to have been by way of settlement of earlier litigation between the parties. It is not apparent to us that the public interest would be served by rendering such common-sense business settlements nugatory, which would be the result of a ruling that the licensee could reopen the issue of validity when sued for the stipulated royalty.

In the case at bar, where a large number of patents were covered by a single license agreement containing no price-fixing stipulation, the result would be particularly awkward if it were held that the licensee may defend by putting in issue the validity of all these patents. Although Automatic's motion for summary judgment and its supporting affidavit make the general statement that none of Hazeltine's patents covered by the license are valid, no concrete attempt was made to buttress these assertions; and the district court concluded: "Furthermore, the defendant does not purport to contest the validity of all plaintiff's patents." 77 F. Supp. at 497. We ourselves have been unable to find from the record that Automatic seriously attempted to raise a "genuine issue" as to the validity of all the licensed patents. If the holding of the *Katzinger* and *MacGregor* cases [fol. 329] were extended to the present situation, because of the restrictive use provision or otherwise, would the licensee, in order to make out its defense, have to establish that each and every one of the licensed patents is invalid? Or could the licensee maintain, in view of the fact that the stipulated royalties are payable whether or not any particular apparatus manufactured and sold by the licensee embodies any of the inventions covered by the patents, that the royalty agreement as an inseparable entirety becomes unenforceable if it can be shown that any one of the 500 licensed patents is invalid? Or, as a third alternative, would the licensee have to show that a substantial number of patents, or the more important patents constituting the "substance" of the agreement, were invalid? If we are wrong in our conclusion that the licensee here cannot challenge the validity of the patents, then we confess we would be at a loss to know how to instruct the district court to proceed with the case upon remand. Whichever of the three alternatives above suggested were followed, it seems to us the resulting situation would be a mess, and the district court would likely be subjected to a well-nigh intolerable burden.

III. Eviction

Questions of direct attack upon validity aside, Automatic relies on the defense of eviction which, as we understand its attempted application here, is in substance a defense of failure of consideration. The argument is based upon these circumstances: At various times in the past, Hazeltine brought infringement suits against third parties based on one or more of eight of the patents licensed under the agreement in suit. Only one of these eight patents was ever passed on by the Supreme Court, and its judgment of invalidity did not extend to all of the claims of this patent. Of the other seven patents, lower courts held all of the claims of [fol. 330] two invalid, and some of the claims of the remaining five were also held invalid. Two additional patents sued on by Hazeltine were held by a lower court not to have been infringed. Some of these patents were litigated before the effective date of the agreement in suit and some after. The record is clear that Hazeltine informed Automatic of the aforesaid Supreme Court judgment of invalidity before the present license agreement was executed, but Automatic alleges that it was then unaware of the judgments of invalidity or non-infringement of the other patents litigated before that date.

Although Automatic did not in this court rely on a defense of fraud or misrepresentation, Automatic does claim that the aforesaid ten patents litigated adversely to Hazeltine were the ones in which Automatic had been chiefly interested; that the judgments against Hazeltine demonstrate the worthlessness of these patents, and that consequently there has been a failure of consideration relieving Automatic of its obligations under the license agreement.

It may be that the defense of eviction or failure of consideration raises a question of local law. The court below correctly ruled that, in so far as local law is controlling, the local law properly applicable under the circumstances of this case is that of the State of New York. See *Klaxon Co.* v. *Stentor Elec. Mfg. Co., Inc.*, 313 U. S. 487 (1941); *Adamowski* v. *Curtiss-Wright Flying Service, Inc.*, 300 Mass. 281 (1938); Restatement, Conflict of Laws §§ 332, 358, Comment *b* (1934).

In our opinion the defense of eviction is insupportable on several grounds.

The mere fact that Automatic may have regarded ten particular patents, out of the more than 700 patents and patent applications covered by the license agreement, as the most important ones licensed, in no sense means that [fol. 331] *both* parties regarded those patents as the "substance" of the agreement and contracted accordingly. The record offers no significant suggestion that such was the case, and the district court concluded that Automatic "has not made any serious effort to show eviction here and could not show it", and that Automatic got "by the contract, what it bargained for, namely, the right to use whatever patents are available for use in plaintiff's large collection." 77 F. Supp. at 497.

Even if Automatic had properly presented this defense, we do not think it could be sustained where a non-exclusive license is concerned. Without attempting a full discussion of the doctrine of eviction,[2] we may assume for present purposes that, where an *exclusive* license is granted and the patent is held invalid, even by a lower court, in a suit between the patentee-licensor and a third party, the licensee may successfully claim an eviction. An exclusive license agreement may be said to presuppose a grant to the licensee of a complete monopoly; if the patent is not upheld in even one suit against an infringer, the desired monopoly is *pro tanto* destroyed, and there may be said to be a failure of consideration. See *Schutte & Koerting Co.* v. *Wheeler Condenser & Engineering Co.*, 295 Fed. 158 (E. D. Pa. 1924); 1 Williston, Contracts § 137 (Rev. ed. 1936). But where the license, as here, is *non-exclusive*, this argument is inapplicable.

To hold that a non-exclusive licensee may base a defense of eviction on lower court judgments of invalidity in suits between the patentee-licensor and third parties would seem inconsistent with the principles recognized in *Triplett* v. *Lowell*, 297 U. S. 638 (1936). There it was held that, even though in an earlier infringement suit against a third party some claims of a patent had been held invalid and the pat- [fol. 332] entee had failed to disclaim them, the patentee might still maintain a suit against another alleged infringer for infringement of those same claims as well as other claims. The Supreme Court pointed out that many times it had upheld claims previously held invalid in litigation that had not reached the Supreme Court; that if in the second suit

[2] See 2 Walker, Patents § 384 (Deller ed. 1937).

the previously invalidated claims were upheld, no question of failure to disclaim would be presented; but if these claims were again invalidated, the court would be faced with the question whether recovery on other claims should be barred by reason of the failure to disclaim the invalidated claims. We think in the present suit against Automatic on the non-exclusive license agreement, it would be anomalous to give greater effect to a lower court's judgment of invalidity in an infringement suit against a third party than would be given to such a judgment if Automatic had not been a licensee and had been sued as an infringer. In short, a holding by one lower court that a patent is invalid is hardly a conclusive determination of that patent's invalidity and hence the "worthlessness" of a non-exclusive license of that patent. See *Appleton Toy & Furniture Co.* v. *Lehman Co.*, 165 F. 2d 801 (C. A. 7th, 1948); *Pope Mfg. Co.* v. *Owsley*, 27 Fed. 100 (C. C. N. D. Ill. 1886). But *cf. Brackett Chemical Co.* v. *Chamberlain Co.*, 63 F. 2d 853 (C. A. 6th, 1933).

Nor do we find that any different rule prevails in the State of New York. It is true that in *Hazeltine Research, Inc.* v. *De Wald Radio Mfg. Corp.*, 84 N. Y. S. 2d 597 (Sup. Ct., Special Term, N. Y. County, Part III, 1948), in ruling on plaintiff's motion for summary judgment, Justice Hofstadter apparently held that the defense of eviction like that advanced in the case at bar was available in New York to a non-exclusive licensee being sued for royalties. We have examined the New York authorities cited by the court, and do not think that they support this conclusion. The [fol. 333] leading case of *Marston* v. *Swett*, 66 N. Y. 206 (1876), after retrial, 82 N. Y. 526 (1880), dealt with an exclusive license; we have already pointed out the important difference in this connection between an exclusive and a non-exclusive license. *Herzog* v. *Hyman*, 151 N. Y. 587 (1897), involved the sale or assignment of a patent, not a non-exclusive license agreement. The distinction is important. See *Marston* v. *Swett*, 66 N. Y. 206, 212-13 (1876); 1 Williston, Contracts § 137 (Rev. ed. 1936). In *Buffalo Rubber Mfg. Co.* v. *Batavia Rubber Co.*, 90 Misc. 418, 153 N. Y. S. 779 (Sup. Ct. 1915), the license was taken by defendant upon a representation that the licensor had a patent application pending, when in fact such application had been rejected by the Patent Office on the ground of prior invention by an earlier patentee; and the court held that the false representation was sufficient ground in equity for the rescission

of the license agreement induced thereby. In *Pomeroy* v. *New York Hippodrome Corp.*, 197 App. Div. 114, 188 N. Y. S. 734 (1921), the license agreement was also made during the pendency of a patent application; however, the patent sought, for the device covered by the license, was refused by the Patent Office, which allowed the licensor merely a patent for a minor improvement on an earlier patent. Appellant also cites *Bottlers Seal Co.* v. *Rainey*, 225 N. Y. 369, 373 (1919); but the passage referred to was *dictum* merely, and furthermore the discussion was with reference to the position of an assignee of an exclusive license. Clearly none of these cases is controlling on the eviction question raised in the *De Wald* case and in the case at bar. It does not appear whether the attention of Justice Hofstadter in the *De Wald* case was directed to the aspects of the eviction doctrine we have already discussed. At any rate we are constrained to believe that the apparent holding in the *De Wald* case is not in accordance with the law of New York as it would be declared by the highest court of that state.

[fol. 334] IV. Repudiation

On September 18, 1947, several months after the filing of the complaint in the present case, Automatic wrote a letter to Hazeltine formally advising the latter, without more, that Automatic "has repudiated and terminated the License Agreement". Automatic asserts that this notice of "repudiation" extinguished its contract obligation to pay royalties. Perhaps a sufficient answer to this contention is that no such defense was set forth either in Automatic's answer or amended answer, or in its counter motion for summary judgment. Furthermore, giving every indulgence to Automatic's contention, such repudiation could operate only prospectively, and would not affect the judgment for minimum royalties for the contract year ending August 31, 1946, nor would it affect Automatic's liability for percentage royalties due for the period up to the date of such "repudiation". In addition to that, so far as it may be a question of federal law, in the absence of a cancellation option in the agreement, or of a substantial default by the licensor, the licensee cannot by any such unilateral notice of repudiation terminate its contract obligation under a license agreement having several years yet to run. *St. Paul Plow Works* v. *Starling*, 140 U. S. 184 (1891); *Ohio Citizens*

Trust Co. v. Air-Way Elec. Appliance Corp., 56 F. Supp. 1010 (N. D. Ohio 1944). But *cf. Martin v. New Trinidad Lake Asphalt Co.*, 255 Fed. 93, 94 (D. N. J. 1919). Assuming that local law governs the matter, we are satisfied that, even if repudiation by the licensee is, in some circumstances, a defense in New York to a suit for royalties, Automatic's letter of September 18, 1947, does not meet the stringent requirements set forth in *Skinner v. Wood Mowing and Reaping Machine Co.*, 140 N. Y. 217 (1893).

The cases which have suggested the existence of some such doctrine of unilateral repudiation have explained that [fol. 335] the licensee may announce unequivocally "that he no longer recognizes the binding force of the agreement, and that he will thereafter manufacture or use the article covered by the patent under a claim of right, founded upon the alleged invalidity of the patent, and in hostility to and defiance of the authority of the patent and the license, so that the licensor can thereafter proceed against him for an infringement of the patent, if he choose so to do." *Martin v. New Trinidad Lake Asphalt Co.*, supra, 255 Fed. at 94. See *Skidmore v. Fahys Watch-Case Co.*, 28 App. Div. 94, 101, 50 N. Y. S. 1016, 1021-22 (1898); *L. Heller & Son, Inc. v. Lassner Co.*, 214 App. Div. 315, 318, 212 N. Y. S. 175, 180 (1925). But as we have already pointed out, under the license agreement in suit Automatic's liability for royalties does not depend upon its actual use of any of the licensed patents in the particular apparatus made and sold by it. If Automatic were permitted to repudiate the license agreement and in fact did not utilize any of the inventions covered by Hazeltine's patents, Hazeltine could not prevail in an infringement suit even if all its patents were valid; and Automatic would thus achieve immunity from liability by non-use of Hazeltine's patents, despite its contract undertaking to pay royalties, regardless of such use, for the *right* to make use of them. Hence, even assuming that a doctrine of unilateral repudiation might in some cases be recognized, such a defense certainly would not be available under the circumstances of the case at bar.

The judgment of the District Court is affirmed.

WOODBURY, Circuit Court, (dissenting):

In my view the decisive question on this appeal is the enforceability of a licensing agreement requiring the

[fol. 336] licensee to pay royalties even though in fact he does not make any use whatsoever of any invention embodied in a patent owned by the licensor. Such agreements as I see it necessarily have the effect of expanding a patent beyond the legitimate confines of the monopoly granted therein, and for many years the Supreme Court, because of the public interest dominant in the patent system, has held licensing agreements having that effect unenforceable in spite of the business convenience or even necessities of the parties. *Morton Salt Co.* v. *Sappiger Co.*, 314 U. S. 488, 492; *B) B. Chemical Co.* v. *Ellis*, 314 U. S. 495, 498; *Mercoid Corp.* v. *Mid-Continent Co.*, 320 U. S. 661, 665 *et seq.*, and cases cited. Therefore, by parity of reasoning with the above cases I would hold the licensing agreement here in suit unenforceable.

On the same day, August 22, 1949, the following judgment was entered:

JUDGMENT—August 22, 1949

This cause came on to be heard on the transcript of record of the District Court of the United States for the District of Massachusetts, and was argued by counsel.

Upon consideration whereof, it is now here ordered, adjudged and decreed as follows: The judgment of the District Court is affirmed.

By the Court: Roger A. Stinchfield, Clerk, by (S.) Dana H. Gallup, Deputy Clerk.

[fol. 337] PROCEEDINGS IN COURT OF APPEALS

Thereafter, on August 31, 1949, mandate was stayed.

Clerk's Certificate to foregoing transcript omitted in printing.

[fol. 338] SUPREME COURT OF THE UNITED STATES, OCTOBER TERM, 1949

No. 455

ORDER ALLOWING CERTIORARI. Filed January 16, 1950

The petition herein for a writ of certiorari to the United States Court of Appeals for the First Circuit is granted.

And it is further ordered that the duly certified copy of the transcript of the proceedings below which accompanied the petition shall be treated as though filed in response to such writ.

Mr. Justice Douglas took no part in the consideration or decision of this application.